The MINING CONGRESS JOURNAL

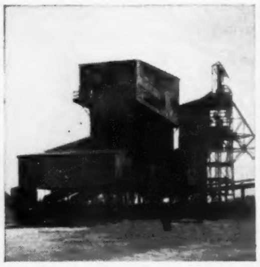
JULY 1932

9th ANNUAL COAL

CONVENTION and EXPOSITION

PROCEEDINGS NUMBER

Experience Solves Problems Economically



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"New Monarch" coal (Consolidated Coal Co. of St. Louis) is prepared at this new large capacity modern Link-Belt plant consisting of a tipple and rescreener. A completely mechanized operation which turns out a fine grade of coal in large volume at low cost per ton. Consolidated is prepared to meet today's markets.

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This plant completely designed and built by Link-Belt for Pond Creek Pocahontas Coal Co., at Raysal, W. Va., has just started production. A unique arrangement in equipment and design, consisting of a Link-Belt--Simon-Carves Washery and other preparation equipment. An ultramodern plant in a State far advanced in modernization.

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From a bed inherently excellent as to quality, but with impurities characteristic of strip mining, Sherwood-Templeton Coal Co., Linton, Ind., have successfully met their cleaning problem with this two-unit Link-Belt--Simon-Carves Washery and Tipple. This is a *repeat* order, sold on the performance of a similar washing unit at their first plant.

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Spring Canyon (Utah)

"If I had to rebuild our tipple and preparation plant, I do not know of a thing to be changed." That is what T. R. Stockett, G.M., of Spring Canyon Coal Co., said of this Link-Belt plant after four years of operation.

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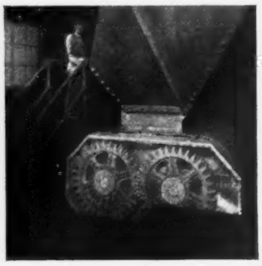
Dumping costs can be reduced by Link-Belt electrically driven and controlled rotary dumps, gravity operated dumps, and electrically operated and controlled mine car feeders.



LINK-BELT

CLEANING-SIZING-HANDLING EQUIPMENT

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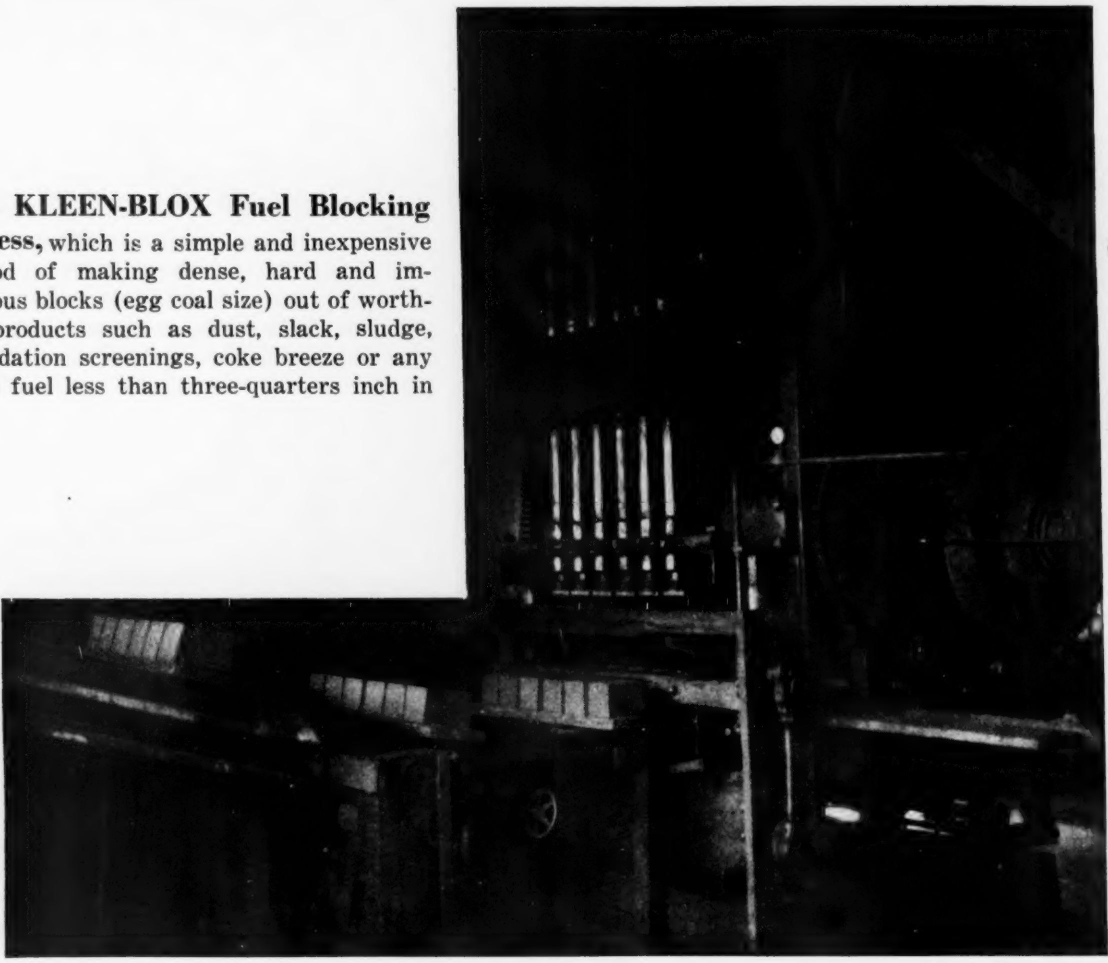
THE KLEEN-BLOX Fuel Blocking Process, which is a simple and inexpensive method of making dense, hard and impervious blocks (egg coal size) out of worthless products such as dust, slack, sludge, degradation screenings, coke breeze or any waste fuel less than three-quarters inch in size.



KLEEN-BLOX press operating in plant of the Glenn Smith Fuel Co., Council Bluffs, Ia.

R and S Recent Contributions to the Coal and Metal Industry

During this depression we have been investigating the needs of our clients to assist them in improving their product at lower cost and for greater realization. We have developed the following valuable additions which will permit us to build preparation plants at lower first cost—with lower maintenance and production costs, also greater realization.

RO-SIEVE screen for Pre-Sizing Dry or Rescreening of Washed Coals

The new RO-SIEVE Screen, a development of our own engineers, by an ingenious combination of mechanical motions creates a rotating, shaking and sieving action which multiplies the capacities heretofore attainable on vibrating screens.

This RO-SIEVE Screen incorporates new and improved mechanical features and its strengthened frame insures long life and a low maintenance cost.

Wuensch Differential Density Process of Coal Washing

The Wuensch Process is introduced in response to a growing demand for extreme refinements in coal cleaning. It is capable of removing the ordinary refuse materials, including slate and heavy bone from coal at an amazingly low cost and yet is so sensitive it can be applied to the most difficult problem of low gravity separation or three product separation with an accuracy heretofore unknown. In principle it is a method

of duplicating on a large scale the operation of the well known laboratory "sink and float test" which uses a chemical of high specific gravity to effect the separation. In the Wuensch Process a heavy medium or mixture of solids and water is used, made up from the natural slimes of the coal itself and consisting of fire clay, gypsum, shale, pyrite and other heavy impurities. This medium is accumulated during the normal operation of the apparatus. No solid matter of any kind is added other than these natural slimes.

This medium is circulated and the "middlings" accumulated in the cone-shaped separating chamber to form a column which gradually diminishes in density from the top to the bottom. This "differential density" feature creates conditions which are even more effective than solutions of uniform density. The light top gravity allows the finer refuse particles to settle immediately while the heavy bottom density prevents the loss of good coal with the refuse.

Phantom View of Wuensch Cone and Refuse Column

THE CONVENTION

GEORGE C. McFADDEN

National Chairman,

9th Annual Convention

Asst. V. Pres., The Peabody Coal Company.

The 9th Annual Convention of Practical Coal Operating men, under the auspices of The American Mining Congress, was held at Cincinnati, Ohio, May 2-7, 1932.

19 coal-producing States sent 742 operating men, representing 243 companies, producing annually approximately three hundred million tons of coal. . . .

Mr. McFadden, National Chairman of the convention, and his committee, composed of 86 coal operating men, representing every producing district, are to be congratulated upon their achievement, and particularly upon the high calibre of the papers which are presented in full, in this issue. These papers have not appeared previously, in any form, and will appear exclusively in this special number of The Mining Congress Journal. . . .

The American Mining Congress, sponsor of the convention and exposition, takes this opportunity to publicly express its appreciation to Mr. McFadden and his committee; to the Manufacturers exhibiting, and to all those who cooperated in making this convention the real service to the coal industry that it is.

The papers herewith presented represent the finest collection of operating data it has been our pleasure to sponsor. . . .

Secretary,

THE AMERICAN MINING CONGRESS

District Chairmen

M. D. COOPER, ***General Superintendent,*** **Hillman Coal & Coke Company.**

H. H. TAYLOR, Jr., ***General Manager,*** **Franklin County Coal Corporation.**

L. N. THOMAS, ***Vice President-General Manager,*** **Carbon Fuel Company.**

G. E. SMITH, ***General Manager,*** **Wise Coal Company.**

J. A. LONG, ***General Manager,*** **Woodward Iron Company.**

K. A. SPENCER, ***Chief Engineer,*** **Pittsburg & Midland Coal Company.**

OTTO HERRES, ***Assistant Manager,*** **Utah Fuel Company.**

E. R. COOMBES, The American Mining Congress, ***Secretary***

L. W. SHUGG, General Electric Co., ***Director of Exhibits***

The Real Coal Problem

By J. G. Bradley*

WE COME HERE this morning to discuss the present situation in the bituminous coal industry and the outlook, and to do that briefly but adequately it seems necessary to run over in review the period since the year 1914, which may be taken as the time when the coal industry, and other industries, and the affairs of the world were what may be considered normal. Up until the time the United States entered the war, the bituminous coal industry functioned, so far as the consuming public was concerned, smoothly, adequately, producing a product which met the needs of the nation's industries and of the domestic consumer of fuel, at prices that were considered reasonable if they were considered at all.

With the entrance of the country into the war, the price of coal skyrocketed. The public authorities became excited, word was passed around there was something wrong with the coal industry, that something must be done about it, the Government must do something, and the Government proceeded to do something. The Government created the United States Fuel Administration, headed by Dr. Garfield, set up an organization of men in Washington with agents in the producing and consuming districts, and succeeded in spending $5,000,000 of the people's money to discover several years later that there had been nothing the matter with the bituminous industry; that the thing that caused the scarcity of coal and brought about the high prices and brought on the creation of the Fuel Administration was a shortage, or failure, of railroad transportation. There was plenty of coal in the mines; there was plenty of labor to mine that coal; the equipment of the mines was adequate to enable the labor to produce the coal in any quantity that was needed.

The war came to an end; coal poured out in the needed volume. The industry might have settled back to the condition in which it was before 1916—that is, supplying the fuel needs without attracting attention—if it had not been for the fact that we came into a new period of disturbance, and that was a period of labor interferences. Following the close of the war the industry was subjected to a succession of strikes which closed up large producing districts, cut off the supply of fuel, created an uneasiness in the public mind, and enabled the agitator to convince the politically minded that something should be done about the coal industry, and that something should be done by the Government.

* President, Elk River Coal & Lumber Co.

This agitation was raised from one end of the country to the other. It was carried to Washington. Presidents of the United States, in messages to Congress, spoke of the chaotic condition of the coal industry. Now what I want to point out to you in connection with that is that whatever chaos there was, whatever was unsatisfactory in the functioning of that business, was the result of outside interference, the result of the interference of a union, and union leadership which got a large measure of its financial support from the anthracite industry.

The result of that period was this: The union was swept out of district after district, leaving behind a trail of suffering, a record of needless expense forced upon the producer and the miner and the public, until the union was practically confined to those districts where certificate laws were enforced. Now a certificate law is a law under which a man is not permitted to work in the mines unless he can obtain from a State authority a certificate of fitness. These certificates are obtained from boards created for the purpose, created to determine the fitness, but they make it impossible in a closely organized district for outside miners to come in where there is a strike, however qualified they may be or however anxious to work. These laws have been a great protection to the United Mine Workers of America. They have saved for it the anthracite district of Pennsylvania, saved for it part of Indiana, and saved for it the State of Illinois.

You might think from that review that the miners' union, the United Mine Workers of America, was not a very important factor in this picture, but let me point this out to you, that any organization with a membership of 150,000 such as the United Mine Workers of America is said to have in the anthracite field, with the power to assess that membership as much as $1 a week, has at the command of its officers a possible income of $600,000 a month or $7,200,000 a year, and that places its officers in a position of extraordinary strength in the industrial picture of this country whether it has any membership in the bituminous fields or not.

Now following the period of active strikes, following the recovery of the industry from the imposition of what is known as the Jacksonville scale, or the highest peak of wages ever paid in the bituminous industry, at a time when the economic situation did not justify an increase in wages, but justified a decrease, following that, the industry has carried on with a certain amount of labor peace. It has filled every fuel need; it has filled those fuel needs at a reducing price. The general industry of the country continued in a highly prosperous condition through the year 1929, but an examination of the bituminous coal industry will indicate that for several years prior to that time there was a slipping in the margin of profit derived from the mining and sale of bituminous coal.

Those were not prosperous years, those last three years prior to 1930, for the bituminous coal industry. It was meeting competition from substitute fuels—from oil, from gas, from water power, from electricity—and it was having to readjust itself to a new market condition. The car shortages of the period preceding the war had disappeared, coal could be mined today and delivered in two or three days to the point at which it was to be consumed. It ceased to be necessary to carry large stocks of coal in storage. The problem became one of mining the coal more efficiently, mining it more cheaply, preparing it better to meet the competition from the substitutes. That is what the operator concentrated upon; that is what he is still concentrating upon.

As we have come into a time of business depression—it is impossible to get around the use of that expression, however undesirable it may be to emphasize it—for the bituminous industry, the conditions of the years 1927, 1928, and 1929 have merely been intensified by this period of business depression. The period of business depression has brought no great change to the bituminous industry, as it has brought great changes to other industries. We have not suddenly come from a period of prosperity into a period of lack of prosperity; we have been gradually moving into a period of lesser prosperity for at least six years.

During this time the miners' union, which has ceased to be a factor in the bituminous industry, has from time to time come forward, using every stage that it could scramble onto, to shout that something must be done for the miner, something must be done for the coal industry, that the coal industry is in a terrible condition, that the coal industry is in a state of chaos, the coal industry is a disgrace.

Those efforts have served to keep the United Mine Workers of America in the public eye and to identify it in the public mind with an industry in which the United Mine Workers of America had

ceased to be a factor, having a membership of only about 12 percent of all the miners employed in the bituminous coal industry.

The record of the United Mine Workers of America, in no case that I know of, shows any contribution toward increased efficiency in the industry, no contribution toward a solution of any of the problems that have come up, only a shout for more wages, for terms and conditions in working agreements which militate against the efficiency which the industry must attain to hold its own and to give work to its employes.

And so we come to the problem of the present time. I do not think that any legislation can help solve the problem of the industry, if I am right in my premise that the problem of the industry is to supply a fuel cheap enough to meet the competition of its substitutes and good enough to meet the competition of the substitutes. That is something which can only be brought about by the elimination of the high cost of operation, the elimination of the mines which market or try to market an undesirable coal. In other words, the low-grade coals and the high-cost coals must disappear from the picture, and they are disappearing.

That is a very unpleasant time to go through in the coal industry. You or I may be mining or attempting to mine a coal which we can not clean to the point where it will meet the competition. We may be mining a coal which can not be mined cheaply enough to meet the competition, or we may not be able to so organize our management as to mine that coal cheaply enough to meet the competition. Under any one of these three conditions we have got to go out of the business, and the sooner we recognize that, and the quicker we get out, the better for our credit and our creditors.

Let us, if that is the case, retire when we can retire honorably. Let us not pin our faith on some change of fortune's wheel, which is going to bring a condition back into the industry in which any old coal, at any old cost, will go. In the long run, that can only be a temporary condition.

I have drawn the picture of the present time as I see it and, having done so, I feel sure that you will agree with me that it is impossible to imagine legislation which is going to change the economic law so as to give any real relief. It is impossible to imagine any agreement among the operators which is going to resist the inevitable movement of those laws of nature. It is impossible to imagine any agreement, even with the sanction of Government, between the operator and the miner that is going to set aside those laws. The operators can, it is true, shape their policies to work with the trend instead of against it.

And yet, in the face of a situation which is as clear as daylight, come forward two members of Congress, neither of them, so far as I know, having had any experience either in the production of coal, its transportation, or its distribution, with a bill known as Senate Bill 2935, familiarly spoken of as the Davis-Kelly Bill, to correct the situation, to save the country, to make the miner and operator rich, to leave the consumer at the mercies of both, and the bill is entitled, "Bill to regulate interstate and foreign commerce in bituminous coal, provide for consolidations, mergers and cooperative marketing, require the licensing of corporations producing and shipping coal in interstate commerce, and to create a bituminous coal commission," and, last of all, "and for other purposes." Who knows what they might be?

It is a little like the rathole that Abraham Lincoln speaks of. A man got into financial difficulties. The only property that could be found was a table in his office, an inkwell, and a couple of chairs. Lincoln looked around the room, took an inventory of the contents, and his eye fell on the rathole. He said, "Put down the rathole; there is no telling what may be in the rathole."

Now, keeping this caption in mind, let's look at the bill. We would suppose that a bill to regulate interstate and foreign commerce in bituminous coal, as the first clause of the caption says, would, in the first paragraph of the bill, say something about regulating interstate and foreign commerce in bituminous coal; but it doesn't. It sets up a commission of five members; it states the salary to be paid to those five members.

"The members of the commission shall each receive a compensation of $10,000 per year, and also their necessary traveling expenses." "They may appoint a secretary and such clerks, experts, engineers, counsel, and other employes as may be necessary to the proper performance of the duties of said commission." There is no provision made for any salary or expenses for this staff. The commissioners are going to get $10,000 a year and their traveling expenses. The clerks, experts, engineers, counsel, and secretary are apparently to receive honorable commissions without compensation.

"The commission," this paragraph says, "shall convene at such times and places as the majority shall determine." North, south, east, west—perhaps it is just as well that the bill does not specify that they are to convene in Washington. Perhaps with this fund for traveling expenses they can go to Indo-China and investigate the source of the latest imports of coal in the United States.

And then the last paragraph, the last sentence of section 1 says: "Said commission shall promulgate rules and regulations for fully carrying out the provisions of this act, and shall annually make full report to Congress."

Let's look at the next clause of the caption. It reads: "Provide for consolidation, mergers, and cooperative marketing." We look at section 2 of the bill and find it says nothing about any of those things.

But section 2 says: "No corporation now engaged in mining and shipping or in shipping coal in interstate or foreign commerce and no corporation which may hereafter seek to engage in mining and shipping or in shipping bituminous coal in interstate or foreign commerce shall be permitted to engage in interstate or foreign commerce in bituminous coal until it has applied for and secured a license from the commission permitting it so to do; and said license shall be granted only upon applicant's acceptance of the provisions of this act and its compliance with the rules and regulations promulgated by said commission for the purpose of carrying this act into effect."

In other words, all corporations, not individuals or firms please notice, shipping or seeking to ship coal in interstate or foreign commerce must have a license from this commission and can not get that license until they promise compliance with the rules and regulations promulgated by the commission for the purposes of carrying this act into effect, whether they know what those rules are, whether the rules have been set out, or whether the rules are yet to be set out in the future.

Then the last paragraph of that section says: "A corporation shall be deemed to be engaged in shipping its bituminous coal in interstate or foreign commerce if it sells and ships its coal in such commerce directly or through the instrumentality of an agent, factor, or broker."

I do not propose to go into any of the legal questions which examination of this bill give rise to. They have been ably analyzed by Judge Rummel before the subcommittee of the Committee on Mines and Mining of the United States Senate, and may be secured from the National Coal Association. But the question arises in my mind, as a rather practical one, whether if I mine that coal and sell it to one of you, an individual, f. o. b. the car in my tipple, and you ship it, I am relieved of applying for a license under this act. You are not my agent, factor, or broker.

The next section, which I shall not read at length, says: "That it shall be lawful for persons, firms, and corporations engaged in the production and interstate or foreign commerce of bituminous coal to enter into any marketing pool or joint selling association approved by the commission after finding by the commission that the same is not against the public interest as an unreasonable restraint of trade, and that every such pool or association as to its schedule or prices and production or trade practices shall be deemed to be valid while such approval remains in force and unrevoked."

This paragraph is apparently intended or purports to legalize pools and selling associations which are not now permitted under the Sherman Anti-Trust Law. But it does nothing of the kind. Paragraph 3 does nothing which any group of men engaged in any industry can not do today without securing a license from anybody, without putting their necks under anybody's yoke. This section 3 is mere bunkum. It is red flannel to catch a bullfrog, and the fellow who swallows this bill with that bit of red flannel deserves to be hooked.

Section 4: "The commission shall hear complaints from any person, firm, or corporation as to the reasonableness of the price schedules approved by it."

Whether that section is meant to apply only to the price schedule permitted in these pools or joint selling associations, which are to be licensed by the commission, or not, it is difficult to tell, because if that were the case it would seem that it should properly have been written as a paragraph of section 3. But it stands as a section by itself and, therefore, would seem to apply to other prices than those exclusively enumerated in section 3.

Then in section 4, the second paragraph, it says: "The commission shall study the problems of exporting coal and shall make such reasonable rules and regulations as will promote the export trade of said licensees. Said commission shall investigate and report to Congress concerning the importation of coals into the United States."

We have today a Department of Commerce, a Bureau of Mines, with a division which is doing the very thing which is listed here as one of the duties of the new commission made up of five members, drawing salaries of $10,000 a year each, with no limitation as to their experience or knowledge of the industry which they represent, or rather are supposed to rule. There is no telling who they would, or what their qualifications, or experiences. And yet they are to be given $10,000 a year each to do something which a bureau of the Government already created and organized and managed by experts has been doing for some time past.

Section 5: "Licensees and their employes shall exert every reasonable effort to make and maintain agreements concerning wages and working conditions and to settle disputes in connection therewith; and in the making of such agreements the licensees may negotiate collectively through an operators' association or by representatives of their own choosing, and the employes shall have the right to deal collectively by representatives of their own choosing without interference coercion exercised by their employers. No such licensee becoming a member of a marketing pool or joint selling association shall make it a condition of employment that the employe shall not join a labor organization, but the right of the mine workers employed by such corporations to organize and maintain their own organization and to deal collectively through chosen representatives shall not be denied or abridged in any way whatsoever.

"If any licensee not a member of a marketing pool or joint selling association, as provided by this act, desires to employ only unorganized mine workers, its employes shall be free to terminate their employment and join a labor organization at will, and no contract of employment which is intended to impair this right shall be lawful.

"Employes of all licensees shall have the right of assemblage for the purpose of peacably discussing and hearing discussed the principles of organized labor and collective bargaining; employes shall be free to purchase their necessities of life where they choose; employes shall be entitled to select a checkweighman to inspect the weighing of their coal, and the weights and scales used by licensees for the purpose of determining the wages of their employes shall be open to inspection by the agents of the Division of Weights and Measures, Bureau of Standards, of the United States, or of this commission.

"Licensees shall make annual reports in the manner to be prescribed by said commission."

Section 5 apparently, in the opinion of many witnesses before the Senate committee, is written in for the benefit of the United Mine Workers of America, an organization which, as I have already said, in my opinion, has made no valuable contribution to the solution of the bituminous coal problem. And yet, in spite of the fact that only about 12 percent of the bituminous miners of the country are members of that organization, that organization, without naming it in the bill, is given the support of this commission to come back into the control of the industry.

I call your attention to the first sentence: "Licensees and their employes shall exert every reasonable effort to make and maintain agreements concerning wages and working conditions." Then I call your attention to the last sentence of the first section of the bill: "Said commission shall promulgate rules and regulations for fully carrying out the provisions of this act." The commission can make rules and regulations, under which the licensees shall exert every reasonable effort to make and maintain agreements concerning wages and working conditions, to settle disputes in connection therewith, and so forth.

Then I call your attention to section 6: "Any license granted under the preceding sections may be revoked by the commission upon a hearing within 30 days' notice to the licensee, upon proof that such licensee has failed or refused to comply with the provisions of this act and the rules and regulations of the commission promulgated to carry the act into effect, and it shall be therefore illegal for the party whose license was revoked to ship bituminous coal in interstate commerce."

In other words, if for failure to reach an agreement with a labor union, under the rules and regulations promulgated by this commission, the licensee's license may be revoked—not after 30 days' notice but upon a hearing within 30 days' notice—and that license, having been revoked, it shall be thereafter illegal for the party whose license was revoked to ship bituminous coal in interstate commerce forever.

In other words, if the licensee's license is revoked, there is no method provided for renewing his license when and if he has cured his default. But it is illegal for him to ship coal in interstate commerce from that time on, from the revocation of his license.

Other provisions of the bill provide fines. Section 7, for instance, provides a fine of not less than $500 or more than $1,000 for anybody who ships coal in interstate commerce without having obtained one of these licenses.

Section 8: "After the taking effect of this act no railroad or carrier subject to the provisions of the Interstate Commerce Act shall build any siding or switch, or cut its lines for any siding or switch to any bituminous coal mine or tipple, until after it has received permission from the Interstate Commerce Commission so to do, and such permission shall only be granted upon approval of the Bituminous Coal Commission."

That takes away or limits the authority of the Interstate Commerce Commission. It gives a further strangle hold of this bituminous coal committee upon the production of coal.

Section 9: "Should any part of this act be held unconstitutional it is the purpose and intention of Congress that the remainder thereof shall continue in full force and effect."

That is a provision often found in present day laws.

Section 10: "This act shall take effect and be in force 60 days after its approval by the President."

Section 11: "There is hereby authorized to be appropriated the sum of $100,000, or so much thereof as may be necessary prior to the passage of the next General Appropriation Act, for the purpose of carrying out the provisions of this act."

The way that is worded, that $100,000 could be used, I suppose, in prosecuting licensees, but it does not appear that it could be used in paying the salary or expenses of the staff.

However, if that is so, that is something that will probably be corrected before the bill emerges from Congress.

Now I want to call your attention to the jeopardy in which the operating corporation is put by this licensing system.

Suppose that a corporation agrees to abide by all the rules and regulations of the commission and obtains a license. Suppose it violates some of the rules and regulations some time in the future. Suppose its license is revoked. What happens to its contractural relations with the land-owner, as to rents and royalties, with the parties to whom it may have sold coal, with the banks from which it may have borrowed money?

It seems to me that the credit of a bituminous coal corporation licensed under this act is immediately destroyed. It can't exist, because its whole future course is one of complete uncertainty, subject to the whim of this commission and its employes. For instance, this commission is given the power to promulgate rules and regulations. Under that power the rules do not have to be made general. They do not have to be written out so all men can read. But the power apparently can be delegated to the employes of this commission.

I think you will all agree with me that this question of delegating powers, of a quasi-legislative nature, to independent commissions is one of the deplorable tendencies of the present legislative age.

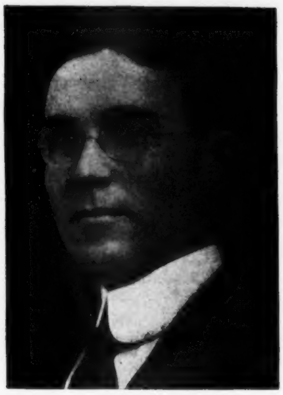
The cost of the commission itself is an addition to the expense of government. Mr. Kelly, at the hearings which are now going on in Washington, has said it is proposed to place the cost of this commission upon the operating companies, upon the licensees, and it is proposed to make that cost nine mills per ton. Whether that cost is placed directly upon the industry in such a fashion or not, it is an additon to the price of coal which the consumer must pay. But why the bituminous coal industry should be singled out to bear the cost of this commission, when the licensees, as taxpayers, pay their share of the cost of all other commisisons, is something that I do not see. It seems to me that the present temper of the times demands not the creation of another commission but the suppression of quite a number which already exist.

The increased cost, indirectly to the public—and I argue this upon the analogy of the increased costs coming to all industries over which government is given control or a share in the management—can easily run to $500,000,000 a year at a time when this country is groaning under enormous costs of government and is making every effort to reduce the price of its manufactured goods to a point at which the farmer and those members of the community who are dependent upon the price of commodities in the world market can afford to buy those goods. And yet, here two well-meaning but misguided gentlemen propose a commission with unspecified costs and an indirect cost to the coal-consuming public—and we are all part of that coal-consuming public—which may run to a billion dollars annually.

(Continued on page 28)

The Real Coal Problem

By J. D. A. Morrow*



I FIND myself in an embarrassing position. I came down here with the expectation of discussing a paper by the Governor of Kentucky. I have disagreed with a good many distinguished public officials with respect to the coal business, and I expected this morning to add the Governor of Kentucky to that list. Since he is not here we have had the pleasure of listening to Mr. Bradley, and I find that I don't have anybody to disagree with because I am in accord with what Mr. Bradley has said.

There are a few things I may add to Mr. Bradley's statement, not that I can improve upon his discussion, but there are some things I think it appropriate for me to say at this time and place since I come here from Pittsburgh.

Mr. Bradley has given you a very clear exposition of the Davis-Kelly bill and what its fundamental faults would do to us in the coal business. I just wish to add this much more to what he has said: In my own view that is the most reprehensible and vicious piece of legislation that has ever been seriously proposed in the United States for any business.

To my mind that bill is the more reprehensible, that legislation proposed there the more vicious, since it is proposed by a Senator and a Representative from the State of Pennsylvania in which coal is a major industry, and since those gentlemen introduced and proposed that measure without having had adequate or sufficient consultation with competent representatives of that business in their state. Their position today is all the more objectionable to the coal producers of Pennsylvania since competent representatives of that business have journeyed down to Washington, have pointed out to those men and that committee the faults and defects and fundamental wrong of that measure, and Senator Davis and Representative Kelly are still in favor of the measure.

This is a time when we may perhaps profitably spend a few minutes in considering a few of the fundamental economics of this present situation. What is the matter with coal? My answer is "There isn't anything the matter with coal." What has happened today is the perfectly logical, inevitable consequences of conditions of the business itself that are inherent in it and inescapable. There is an old economic law that we have all heard of a good many times, called the law of supply and demand. It is just as positive, just as definite and certain in its operations as the law of gravitation, and neither Congressmen in Washington, nor kings and emperors abroad can change its operation. It has been tried many times. It was tried by the steel kings of Germany, by the coal and coke barons of the Ruhr, by the coffee planters of Brazil, and nobody has escaped its consequences. Neither will Senator Davis or Representative Kelly or any other public officials in Washington find a way around it.

There is also a special feature of the law of supply and demand that applies to bituminous coal. The economists would say that the law respecting prices in that industry is this: that the price of any commodity which can be produced in practically unlimited quantities, that is, in quantities beyond those required by the normal market for that commodity, tends always to gravitate down to the level at which the cheapest units of that commodity can be produced. The contrary collateral of the law of supply and demand is that commodities which cannot be produced in quantities sufficient to meet the normal demand tend to find their prices fixed by the cost of producing the most costly units that are bought and sold in the market.

Unfortunately in bituminous coal the United States has such a wealth of easily developed deposits, there are so many mines available for production, so much coal can be readily shipped, that our prices are fixed for us, inevitably, definitely, certainly, by those mines that can produce the most cheaply for the same quality of coal.

Now I haven't found any Washington official, whether he is in the cabinet or whether he is in Congress, who has the intellectual courage and honesty to face that simple elemental economic law and undertake to deal with it, not a single one. They produce measures like this one here, nothing at all, as Mr. Bradley says, except political bunkum and we are asked to pay for that bunkum.

I regret to say that there are some coal operators—we have one or two in Pennsylvania—whose understanding of their own business or whose degree of mental desperation is such that they would grab even this Davis-Kelly bill in the hope that if it isn't any good, perhaps it might be changed to make it some good.

I have no such confidence in any such result, and I want to say here that I positively know that those men have very few sympathizers in the ranks of the coal operators in Pennsylvania. I question if they have very many in the ranks of the coal operators of Kentucky, West Virginia, Indiana, Illinois, or any other state. They are deluded. They haven't thought things out clearly. They simply want somebody to do something for them.

One of those men suggested that if coal perhaps was affected by a public interest it might be declared a public utility, regulated and dealt with accordingly, and he bolstered up his belief that some such action as that might be helpful to the business by saying, "Look at the railroads, look at the public utilities, how prosperous they have been under regulation."

That particular gentleman took a day off and came to my office to convince me of the desirability of this idea, and I said to him—he is a competitor of mine—"I will tell you what I would do. If we could set up this public utility idea so that the same character and degree of monopoly is accorded to certain coal producers that is accorded by law to every railroad, to every power plant, electric light plant, gas works, etc., I might favorably consider that thing, provided the Pittsburgh Coal Company can have the exclusive franchise to sell all the coal in western Pennsylvania, northern Ohio, and on the Great Lakes." He didn't like that idea at all. "I said right there is where your parallel takes you. No other electric company can come into Pittsburgh and sell electric current, or run street cars, or do anything of that kind in our town. The only reason that they are able to make money, to charge these rates that you are talking about that are so profitable, is because the law has granted them a monopoly." I don't find anybody proposing that any monopoly be granted the coal business. I am not advocating it myself. I merely cite the difference in fundamental conditions so that if anybody springs that idea on you you will know the answer to it.

As I said a moment ago I have no confidence in the idea that anybody down in Washington is going to help us, nor can I understand how any sane business man can have any such confidence when he calmly takes a look at the actions of the present Senate and House of Representatives with respect to a very simple, clear-cut definite and immediate business problem; namely, the job of balancing the budget of the United States Government. Look what has been going on down there. There hasn't been a single thing done by the House of Representatives or by the Senate so far in the consideration of that legislation that would give you or me

(*Continued on page* 27)

* President, Pittsburgh Coal Co.

Anthracite Problems

By E. W. Parker*

PARAPHRASING somewhat liberally the words of the late Mr. Henry before the House of Burgesses in the then Colony of Virginia—"We have no way of judging of the future but by the past, and judging by the past," there is reason for the belief, optimistic as it may appear, that the coal industry and particularly the anthracite end of it, will, without the benefit of Government aid, succeed in extricating itself from the slough of despond in which it has been mired for the last few years.

I am going to confine my remarks to the anthracite branch of the industry, since the subject assigned to General Disque is limited to the problems of anthracite.

Let me, in order to draw a few comparisons, go back for a brief moment to about a century ago when anthracite was a struggling infant industry. As you doubtless all know, after the first few wagon loads of anthracite were hauled at considerable expense and loss to Philadelphia and the value of anthracite as a fuel had been demonstrated, the only means of getting the product to market, was, for a number of years, by water—natural streams, slackwater navigation and canals—supplemented to some extent by inclined planes. Then just a little more than a century ago came the steam railroads, the first to be constructed being the Delaware & Hudson Canal Company's railroad, planned in 1826, completed in 1828 and carrying its first shipments in 1829. But that was only to bring its coal from the mine to the head of its canal. It was only a beginning but it demonstrated that the railroad was the one thing needed for the economic development of the industry, and it came.

For three decades, from 1830 to 1860, there was much projecting and building of railroads into the anthracite fields. But the point I wish to emphasize and to which to call your particular attention is that these enterprises received not only the consent but the encouragement of legislative enactment, state credits being extended in order to secure the capital necessary for the building of the railroads and the development of the mines. Not only were these enterprises aided by state credit but the legislatures were liberal in the charters given to the railroads. The bogey man of railroad ownership of anthracite mines had not risen. The railroads were authorized to aid corporations in the development of coal lands, either by purchase of stocks or bonds, or by guaranteeing payment of principal and interest. The Delaware, Lackawanna & Western Railroad, for instance, was by its charter, authorized to acquire and hold coal lands and to mine, purchase and sell coal, as well as to transport it.

There are, I think, few who will deny that the coordination of the mining and transportation interests in the early days of the anthracite industry was necessary to secure its development. It followed as a corollary to such unity of interests that from 75 percent to 80 percent of the anthracite tonnage came under the control of the railroad companies or of mining companies owned by, or affiliated with, them. It must be admitted that as a result of this railroad ownership or control there developed later certain abuses, principally in the way of discriminations against operators not affiliated with, or subordinate to, the railroads. And right here, I should like to call particular attention to the fact that it has never been shown, nor from my own somewhat intimate knowledge of the business, could it have been shown, that the combination of railroad and mining interests had resulted in any effect inimical to the public.

But the individual operators, most of whom had their entire fortunes (and then some) invested in their anthracite properties, did suffer, and during the last decade or so of the nineteenth century and the early part of the present one, there was an almost constant state of industrial warfare between the rival interests. Why, in 1891, when your present orator first came in contact with the coal mining industry by his appointment as statistician of the U. S. Geological Survey (remember, that was more than 40 years ago) there was hardly such a thing as an anthracite freight rate. Most of the "railroad" company product was sold at delivered prices, and generally in highly competitive markets and the transportation costs were simply a part of the total delivered cost. The individual or independent operators were not so fortunately placed, but had to make the best bargains they could with the railroads for the transportation of their product. Feeling naturally ran high. In their struggle to secure rates that would enable their coal to meet the "railroad" product on equal terms, the independents had the sympathy of the public and of the politicians, which was finally reflected back to the railroads, and in 1890 a change of policy was inaugurated.

In that year the New York, Ontario & Western Railroad agreed to transport the coal mined on its line for 40 percent of the tidewater price, and later agreed to buy the coal and pay for it on the same basis. From this plan was later developed what became known as the 65 percent contracts, by which the railroads bought all of the "independent" coal, paying for it on the basis of 65 percent of the tidewater price as determined by the Bureau of Anthracite Coal Statistics, a statistical bureau maintained by the anthracite carriers. It should be stated here that in making these bargains, the railroad companies stipulated that the coal conform to certain standards of equality. The specifications with reference to sizing was not as rigid as those in effect today, and egg or stove coal from one colliery or district might differ somewhat from the products of other collieries or districts. But the specifications regarding impurities were strictly enforced and really represent the first attempt at actually standardizing anthracite preparation.

In previous appearances before the American Mining Congress, the speaker has referred to some of the troublous times through which the anthracite industry has passed, so I am not going to rehash any of that stuff, but having in mind the conditions under which the industry was compelled to struggle during the past winter (so-called), I quote a paragraph from the *Coal Trade Journal* of March 13, 1878, 54 years ago:

"Owing to the poor demand resultant from the mild weather that has predominated recently throughout the land, the collieries of all companies in the Lackawanna and Wyoming regions are running on partial time; this seems to exert a potent influence against any large purchases and this adds much to the general uncertainty now prevailing in the coal trade."

In February of that year, the Delaware, Lackawanna & Western Railroad sold 50,000 tons of anthracite at auction, the realizations on the domestic sizes being respectively: Egg coal, \$3.15½; stove, \$3.55; chestnut, \$3; pea, \$2.12½. Sizes below pea went to the culm bank. These realizations are supposedly at tidewater since in the previous year the average price at New York Harbor had been reported as \$2.50 a gross ton.

It would be interesting to know what proportion of this went to mining departments, and what to the transportation. These conditions were the result of three consecutive years of "hard

* Director, Anthracite Bureau of Information.

times" in the anthracite industry. It may well be doubted if the parlous times the industry has recently experienced were any worse. As a natural result of them there developed an attempt on the part of the executives of the railroads to effect some sort of an understanding by which the bankrupt-making conditions could be corrected, and an agreement was reached by which certain percentages of the tonnage were assigned to the different systems. The fixing of prices was left to each. The agreement on tonnage percentages, and for restriction in production, seems to have been loosely held, however, and the last 20 years of the nineteenth century were notable for the attempts that were made to effect a working combination.

The trying history of that period constitutes too long and complicated a story to be discussed in detail at this time. Suffice it to say that the attempts at cooperation of the railroad companies, combined with the plights of independents to which reference has already been made, as having the sympathy of the public, were made the *casus belli* for attacks against the industry by Government agencies and during the first quarter of the present century the anthracite industry was the center of attack by Federal and state authorities from almost every conceivable angle.

The initial appearance of the Federal Government in the affairs of the anthracite industry was the appointment of the Anthracite Coal Strike Commission by President Roosevelt in 1902. That was, however, for the settlement of a labor controversy and was not for the purpose of correcting any naughty behavior, real or imagined, on the part of the anthracite operators or carriers. For obvious reasons the speaker is not going to say anything in criticism of the work of that commission. It is only referred to here because it resulted in an increase in wage rates, which compelled an advance of 50 cents a ton in the price of the prepared sizes of anthracite to the consumer, and was the beginning of a series of advances, extending over a period of 20 years, and culminating in 1923 when the then and now Governor of Pennsylvania forced another 10 percent advance on already inflated wage scales and overburdened payrolls, and from which no relief has been secured, although the index of the cost of living reached its peak in June, 1920, and has shown a declining tendency since that date. Wages in every other line of industry have receded. It has had much to do with creating the present day problems that confront the anthracite industry.

The first assault on the industry by the Interstate Commerce Commission which started "investigating" in 1903 kept up until 1906, without accomplishing anything. Also in 1903 Congress enacted the Hepburn bill, under which suits instituted by the Government resulted in the dissolution of the railroad and mining interests, and as a consequence, the mining companies being thrown upon their own resources, were compelled, if they were to continue in business, to advance the price of their product to the consumer. Such was the benefit derived from that Government action.

In 1912, by decision of the United States Supreme Court the 65 percent contracts were abrogated and the public paid.

The steps by which, since 1912, anthracite wages and prices have reached their present level and the reasons therefor are shown in the following table. There was no increase in the wage rates from 1903 to 1916.

Table

Changes in effect	Egg	Stove	Nut	
April 1, 1913	$3.75 *	$4.00 *	$4.15 *	
May 1, 1916	4.15 *	4.40 *	4.50	Increase in wage rates by agreement of May 5, 1916.
May 1, 1917	4.45 *	4.70 *	4.80 *	Increase in wages by agreement of April 23, 1917.
September 1, 1917	4.45	4.70	4.80	Fixed by U. S. Fuel Administration.
December 1, 1917	4.60	5.05	5.15	Executive order 11/28/17 increase 35 cents broken to pea, inc.
November 1, 1918	5.65	6.10	6.20	Executive order 11/7/18, effective 11/1/18, increase $1.05 cover wage increase.
October 1, 1919	6.35	6.60	6.70	Increase of 50 cents a ton authorized by U. S. Fuel Administration, prices advanced 10 cents a ton monthly, April to September, inc.
May 24, 1920	7.20	7.45	7.55	Award of the Wilson Commission. Retroactive to April 1, increasing wages 17.4 percent.
October 21, 1920	7.60	7.95	7.95	
January 1, 1921	7.75	8.10	8.05	Strike 4/1/22, resumed operation 9/11/22.
September 11, 1922	8.10	8.20	8.20	Approved by Pa. Fuel Com'n and Federal Fuel Distributor, Pa. State tonnage tax added to cost.
December, 1922	8.30	8.30	8.30	
September 1, 1923	9.15	9.15	9.15	Strike 9/1/23 to 9/18/23, inc. Settlement of strike by Governor Pinchot added more than 75 cents a ton to mining cost.
January 1, 1924	9.15	9.15	9.15	
April 1, 1924	9.15 *	9.40 *	9.15 *	

* 50 cents off in April.
40 cents off in May.
30 cents off in June.
20 cents off in July.
10 cents off in August.

From 1914 to 1923 there were no less than 14 investigations of the anthracite industry. Some were Federal, some state, some legislative, some administrative, some judicial, and it is yet to be shown that any one of them found the industry guilty of any action, individually or collectively, that was prejudicial to the anthracite consumers. In fact one of these investigating commissions had the temerity to state in its general conclusion that it was "impelled to the conclusion from all the facts and testimony before it, that the percentage of increase in the price of anthracite has not been disproportionate to the increased cost in the production of anthracite," and the commission also said: "While the conclusion of the commission will doubtless not be popular, it is founded upon the bald facts developed by this investigation, and it is, therefore, impossible under these facts that your commission should find other than they do."

Well, the net result of all these increases in wages and advances in prices is that the wage rates in the anthracite mines from 1913 to 1923 nearly trebled and prices were advanced a little more than double (although I might add here that during the same period taxes were quintrupled nor has there been any let up in taxes either).

In addition to the disadvantageous position in which the anthracite industry has been placed by the conditions as outlined, it must be remembered that it lost some considerable markets by the strike ordered by John L. Lewis in September, 1925, and which, extending throughout the winter, compelled the customary anthracite users either to take on substitute fuels or freeze to death and most of them, strange to say, chose the former. To get back those markets and to retain what they still have left in the face of the conditions which have been outlined, is the problem with which the anthracite operators and the executive director of the Anthracite Institute with his corps of assistants, are contending. Its solution requires as a *sine qua non* lower prices to the consumer. It would seem that the operators have done their share in the reductions announced in February, and the usual spring reductions effective April 1, for it is some sacrifice for an industry, the greater part of which was in the red to the extent of over $9,000,000 in 1929, the latest year for which the figures are available, to take the risk of further losses at this time.

The problems facing the anthracite industry today are those of recovering the markets already lost because of the reasons stated and to gain additional outlets for the product. The industry, through the Institute under the leadership of Gen. Brice P. Disque, its executive director, is meeting the situation, if not entirely with a united front (for as has been indicated there is a somewhat lively competition within the industry itself), at least with a determination to reestablish anthracite on its throne as the premier fuel for domestic use. In a recent address before a group of retail dealers, General Disque said:

"After using anthracite for an entire lifetime, myself, and after infinitely studying it for only six months, with a mass of information at my hands, I believe more than I ever did in my life, that it is basically the fuel for domestic consumption. I haven't discovered anything that weakens my faith in its possibilities. The more I learn about competing fuels, the more I discover their defects. The more I learn about, and have learned of anthracite, the less criticism I have of it."

Now, as to methods I have already referred to the drastic cut in prices made in February. Dealers' margins in some of the metropolitan districts have already been materially reduced, and with lower dealer first costs general reductions in margins may be anticipated. Householders have always been, and always will be willing to pay a reasonably higher price for anthracite than for other solid fuels. It doesn't smoke, has no bad habits, doesn't go out nights. It doesn't explode, or asphyxiate, as will gaseous or liquid fuels. It speaks for comfort, convenience, cleanliness, econ-

(*Continued on page 42*)

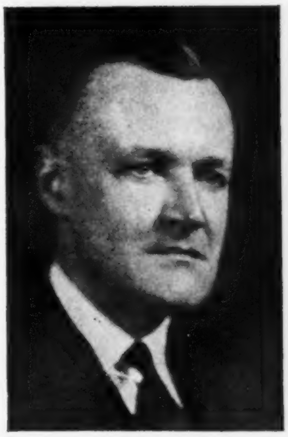
Problems of Management

P. C. Thomas
Chairman

Vice President,
Koppers Coal Company

Economies of Management

M. D. Cooper
Chairman



Division Superintendent,
Hillman Coal & Coke Co.

Engineering as a Factor in Successful Operation

By R. L. Ireland, Jr.*

I USE this title because this is the title that was assigned me. Personally, I would prefer to see it "Engineering Is One of the Most Important Factors in Successful Operation." Of course, I am a little bit prejudiced because I used to be an engineer myself, but as an engineer told me who was fired because his boss said he was too damned "theatrical," and who later got a job as a bond salesman, I have "sold my tools."

The average mine manager or superintendent I find is a good deal like a blast-furnace friend of mine who used to tease our consulting engineer and, on one occasion, together with the plant superintendent, framed him. They got in an argument with the "exponent of the slide rule" one night at dinner. The manager claimed that he always had to multiply an engineer's estimate by two. The plant superintendent disagreed with this. He said you're never safe unless you multiply it by two and then add a car number. This led to the remark on the part of the manager that an engineer was nothing but a "necessary evil," to which the superintendent replied, "an engineer is not even that; he is an unnecessary evil," after which the fight was on.

But, in spite of all we say about the engineers, they are like women; you can't get along with or without them; and this is just as true in coal mining as any other branch of industry. The coal industry as a whole has suffered because the cost of the finished product contains a greater percentage of labor cost than practically any other article on the market, and because the major operation in preparing coal for market is done by human machinery commonly known as "loaders." Because there is no depreciation or depletion on this equipment, it has been possible for the coal operator to maintain at little overhead cost, an excess producing capacity, with the result that he maintains on his pay roll an excess number of this type of machinery, which, in the last analysis, are human beings like ourselves. Because through generations the coal loader has not gotten steady employment, and because he is an individual contractor, he has built up a precedent that he need only work when he pleases and only so long as he pleases, regardless of the operating time of the mine. This in turn has resulted in coal mines maintaining excess working places and excess loaders, so that when men lay off the normal production will not be affected.

No other well-organized business today maintains the unbalanced amount of excess capacity that the average coal mine maintains, and this, to my mind, is the first thing that must be corrected to put coal mining on the same economic basis that other successful industries enjoy.

But when the coal operator does away with his excess working places and excess development and cuts down his number of loaders to the actual number required to produce his normal production, his problem of balancing his development with his wide work and having the proper amount of wide work ready to go into production when existing wide work is finished, is made much more difficult, and this is where the engineer comes in.

It is our practice to have our maps extended every three months and to show on the blue prints, in a different color for each quarter, the excavation made in the preceding quarter, and, in addition to this, to show on the blue print the projected excavation for the ensuing quarter. The projections are arrived at in the following manner: The engineer calculates the life of the existing wide work sections and marks on the blue print the date on which each of these sections will finish. Then he calculates the amount of narrow work that must be driven to furnish a proper amount of new wide work, giving the date on which the various room entries must be driven their distances, so that the laying of the necessary room turnouts can be completed by the proper time. These projections are then submitted to the superintendent for approval and, having obtained this, are placed on the blue prints which are distributed to the manager, mine foreman, section foremen, etc. In this way the mine foreman and his assistants have a graphic production schedule before them, similar in nature to that which is supplied to equivalent personnel in other industries.

This, however, is only one step. As each step in efficient operation is obtained, other steps present themselves, and this is where the time-study engineer comes in.

We make a practice of laying track for our loaders and doing the drilling and shooting, both of coal and draw slate. Our cutters are likewise paid by the day on a day rate, with a bonus for tonnage over a certain base. Obviously, the cost will be improved if the workings can be laid out so that the cutters, loaders, and shooters and track men can have a full day's work in a restricted area. The first step in this determination, therefore, is time study of the various operations so that the proper number of rooms on an entry can be turned.

Under the heading of transportation, the proper location of passways and the proper length of rooms can best be determined by time study. In mines whose active workings are a long way from the tipple, time study is helpful in arriving at the proper length of trips and the number of main haulage locomotives necessary to get the best results.

Where hand loading is replaced by mechanical loading, the time-study engineer is more important than ever. Because of the greater production of loading machines, the flexibility of your loading equipment is naturally diminished, with the result that the laying out of the mine and getting the wide-work sections prepared on time becomes a much more difficult job and one that can only be properly done in an engineering office.

At our all-mechanical mine we use three types of units. The equipment in each unit is the same; made up of a track-mounted cutting and shearing machine; a truck on which is carried the electric post drill, insulated powder box, etc.; the track-mounted loading machine; a gathering motor; and the track layers' truck. The number of men in the crew and the standard production per crew vary. We class them as follows: Narrow-work units, which drive only entries; combination units, which drive entry, room necks, and a limited number of rooms; and wide-work units, which drive only rooms. The combination units were developed in order to maintain the balance between development and wide work. But even with this cushion, it is still a problem to maintain at all times a uniform production without either getting ahead or behind on development. Without time study and careful engineering, this relationship could never be maintained, and in this type of mine it is most essential that the mine foreman and his assistants carry out strictly the projections furnished them each quarter.

We started our mechanical program on straight day rates, but, being a believer in pecuniary incentive, we decided to adopt a bonus plan. Through detailed time study of each job that had to be done in connection with each type of loading unit, we determined the number of man-hours of work necessary to keep the loading machine busy at 100 percent efficiency. From this we determined the number of men necessary to have on a crew, and how to distribute the work among them. We then used 79 percent efficiency as the base tonnage for which they would receive what had been the day rate, and paid a sliding scale bonus; beginning with one-half of 1 percent for 80 percent efficiency and increasing on the sliding scale until a 15 percent bonus was paid for 100 percent efficiency. This plan has worked out very well and, like any other plan of similar nature, requires the careful supervision of a competent time-study engineer in order to insure equitable application.

An interesting side light on this introduction of engineering and time study into coal mining occurred recently. A section boss was raising hell with one of the drillers and shooters because he felt the man was not working hard enough. The man was later heard to say to one of his associates, "I don't mind the boss givin' me hell when it's justified, but I was going at the rate of a 10 percent bonus while the loading machine was only making 5, at the time he called me."

(Continued on page 56)

* Vice president, Hanna Coal Co.

Cash—A Coal Mining Implement

By Newell G. Alford*

WITH markets shrinking and losses increasing we find ourselves trying to hold cash and meet obligations without making payments. This has happened before in coal mining, but never to so great a degree as now. The urgency for cash makes us skeptical about expenditure for maintenance items that can be postponed on any pretext. Cash is now the most important working tool of the industry.

Coal mining, and most especially the plants depending on steaming consumption, has lost caste as a solvent industry. Coals of medium or lower quality are, generally speaking, approaching an impasse more rapidly than the high grades, but, as the steam and railroad fuel coals are sold with rapidly lowering prices, the entire scale of realization collapses.

Where margins once existed on premimum coals, these have been absorbed by price reduction. Wages have been lowered to help in stemming the rising tide of losses, only to have losses continue as fixed charges mounted with declining output.

Today nearly every mine operator is struggling for a cash gain. For bidding purposes he estimates his costs before depreciation and depletion; this practice is almost universal. Capital investment, through these operations, is now being given away to coal consumers at the rate of over $20,000,000 a year—and at the expense of the investor.

As this condition becomes more severe the bituminous industry east of the Mississippi River tries to oppose the tide of bankruptcy with lawful sales organization. If successful by the fall of this year, many mining failures will be saved with the advent of a coal-burning winter. In spite of everything there will be many financial casualties where the salvation of winter will not arrive in time.

Meanwhile, the "Law of the Jungle" is continuing to work out the survival of the fittest and solving nothing. Although this operation actually makes insolvent mines, only a small part of their output really stops with bankruptcy and the continuing production weakens stronger companies.

A bankrupt plant sells for not over 15 percent of its depreciated reproduction cost. It probably brings less. However, the capital costs for continuation are extremely small.

From 1915 to 1920 there was practically no financial embarrassment to coal mine operation. The surplus momentum of these years carried the industry through the slump in the summer of 1921. The coal and railroad strikes of 1922 really ended the coal industry's prosperity, and the real decline began with the advent of competitive coal selling in 1923.

The operation of the "Law of the Jungle," beginning in 1923, is shown in Chart No. 1.

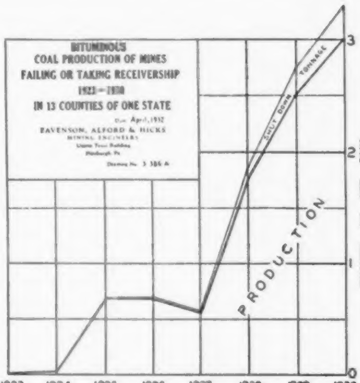


Chart 1

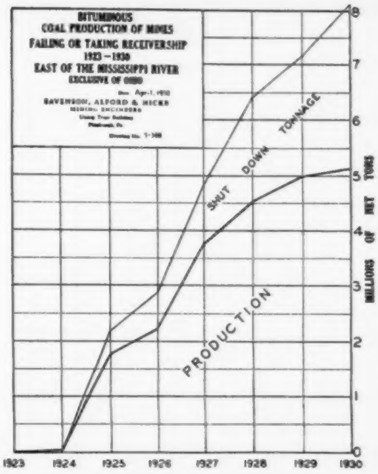
This chart is based on reports by R. G. Dun & Company, of the commercial failures or receiverships among bituminous coal producing companies in Pennsylvania through this period.

In the production curve is shown the increasing volume of bituminous coal mined by defunct companies or by those that have been reorganized with scaled down capital after a sheriff's bargain sale.

The "shut-down tonnage" is shown as cumulative. It represents the outputs of embarrassed plants, now idle for all reasons except exhaustion, and approximates what the production would have been had operation continued. On this basis the extinct production in this area is about 9.9 percent of the total continuing output volume gone bankrupt in the eight-year period.

The remaining cumulated three millions of tons of bankrupt output in 1930 was mined practically without any capital cost, meanwhile reducing the sales realizations of liquid producers and progressively wiping out the margins of solvent corporations as the volume of bankrupt tonnage increases.

Chart 2



This chart is based on similar financial failure information by R. G. Dun & Company for the seven coal-producing States east of the Mississippi River, excluding Ohio. As in Chart 1, the potential production, shut down following failure, has been corrected downward in proportion to the 1930 output decline for the area.

The 1930 decline in these seven States was identical with the shrinkage in the Nation's production for the same year. In spite of this, however, the tonnage actually produced from the defunct mines in 1930 continued to increase, although at a somewhat slower rate than the previous years.

This does not take into account the mines that have shut down voluntarily without breaking up or becoming insolvent.

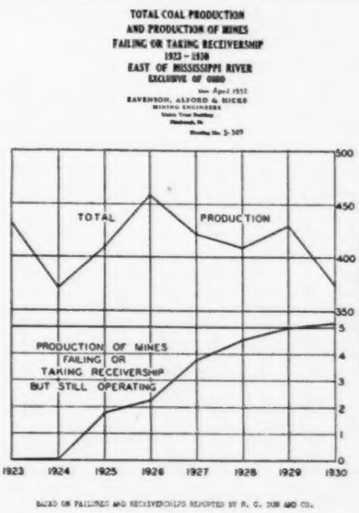


Chart 3

This compares the trend of total production east of the Mississippi River, from 1923 to 1930, inclusive, with the trend of production from mines failing or taking receivership but still operating. The latter curve is identical for values with the production curve in Chart No. 2.

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* Eavenson, Alford and Hicks.

Table 1

Bituminous Coal Companies Failing or Taking Receivership, 1923–30, Inclusive
(4/28/32)

State	Companies (1)	Companies (2)	Companies (3)	Mines (1)	Mines (2)	Mines (3)
Alabama	2	6	8	2	9	11
Illinois	1	5	6	2	7	9
Kentucky	14	13	27	16	21	37
Maryland	0	1	1	0	1	1
Pennsylvania	18	29	47	46	42	88
Tennessee	1	1	2	1	2	3
West Virginia	15	37	52	23	49	72
Total	51	92	143	90	131	221

(1) Production continued after failure.
(2) Production stopped with failure.
(3) Totals.

Table No. 1 shows the number of bituminous coal companies reported as failing in each State east of the Mississippi River, except Ohio, through the eight-year period, with the number of mines operated by the failing corporations. These are divided to give the number of each continuing after and stopping with bankruptcy proceedings.

Table 2

Bituminous Coal Companies Failing or Taking Receivership, 1923–30, Inclusive
(4/28/32)

States	Maximum (1) in.	Maximum (2) in.	Minimum (1) in.	Minimum (2) in.	Average (1) in.	Average (2) in.	Average (3) in.
Alabama	48	96	30	29	39	50	47.2
Illinois	—	96	—	52	48	69	65.5
Kentucky	78	84	48	34	57	55	56.0
Maryland	—	—	—	—	—	54	54.0
Pennsylvania	85	96	36	30	56	41	51.6
Tennessee	—	—	—	—	50	46	48.0
West Virginia	96	132	40	34	62	53	57.8
All mines	96	132	30	29	57.1	54.3	55.4

(Coal thickness)

(1) Where production continued after failure.
(2) Where production stopped with failure.
(3) All failing mines.

In the same general arrangement, Table No. 2 shows the reported maximum, minimum, and average thickness of coal worked in the mines failing or taking bankruptcy in the same eight-year period.

Analysis of the data involved in this study shows no relation between thickness of coal and the forces that caused total abandonment after failure. While the thickness was nearly always somewhat greater where the mines continued operation, the reason for abandonment was coincident with inferior quality and development for lower grade markets.

From the data available it would seem that failure resulted from expansion or development, with excessive investment or adverse mining conditions, for steam markets on the peak of coal prices. In no case was a strictly quality coal producer found among the failing mines.

No relationship could be established between differentials in wage scales or freight rates and the ability of a company to operate and stay solvent.

Since mine production figures for 1931 are not yet available in all the States included, the study could not be carried to the first of this year. It is intended, however, to continue the work to include the year 1931 with a study of the bituminous companies finally quitting operation because of shrinking surpluses through either dissolution or write-off processes.

It is not amiss to consider the effect these conditions have had on coal securities.

The necessity for helping our mining labor is paramount, but the obligation of the industry to its investing public is almost as serious. Certainly the industry must preserve its integrity with the investor, else coal securities in the future will be utterly without a public market.

The absolute necessity for preserving the integrity of coal-mining securities is evident from a study of the performance record of some of the leading coal-company securities, that have been distributed to the investing public through regular channels and listed for trading on some of the leading exchanges.

A study of 12 coal-mining corporations has been made from financial data published by the Standard Statistics Company, Moody's and Poor's, representing something over 10 percent of the country's annual production.

This study shows how the present financial troubles of bituminous coal began in 1923 with lack of cohesion in sales.

Chart No. 4 shows that 8 of 12 large mining corporations were earning money for the common stockholders in 1923, the maximum yield being slightly over \$20 per share. Meanwhile the common stockholders in four corporations were without earnings, the maximum deficit per common share in the worst case amounting to about \$9. Since 1923 the common stockholders in 11 of these corporations have progressively gone lower in the scale of potential dividend collectors with the passing and cumulation of preferred dividends.

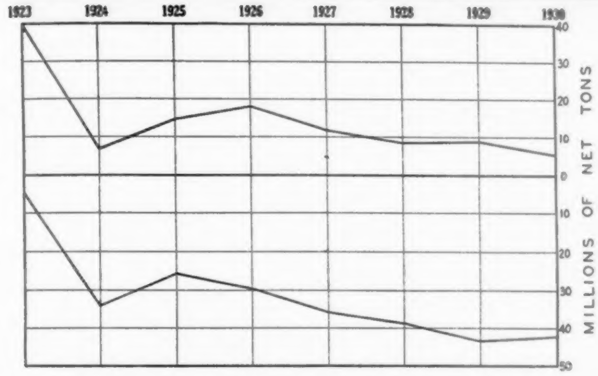
In 1930, 1 of the 12 corporations was earning dividends, and in the balance of companies the common stock deficits ranged as high as \$8 per share, without accounting for arrears on outstanding preferred stock.

Chart No. 5 shows the output of these 12 corporations and the part of the total mined with and without earnings for the common stockholders.

With no decrease in total annual output, you will notice that as much tonnage was mined and sold in 1930 without earnings for the common stock as was produced *with* common earnings in 1923.

Chart 4

EARNINGS AND DEFICIT PER SHARE OF COMMON STOCK



OUTPUT MINED AT PROFIT AND LOSS

Chart 5

The combined market price of outstanding bonds is at present about 35 percent of the outstanding par value as issued, but this is not shown on the chart.

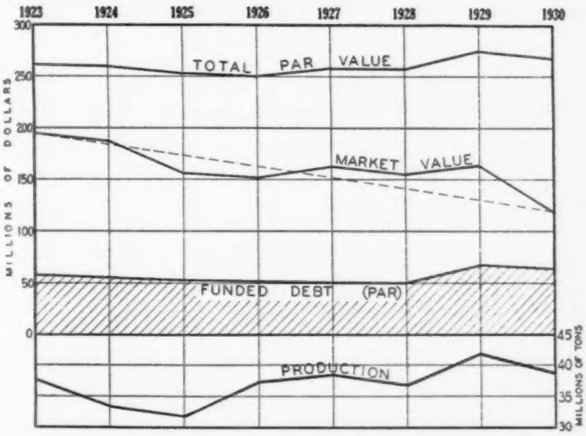
It is much too easy to overinterpret a chart of this kind, but what applies in these particular cases for over 10 percent of the Nation's output may be taken as fairly indicative of the conditions prevailing generally.

From the records of these eight years, it is easy to see that the present ills of the industry are not chargeable to depression and that, unless it is able to gain the relief it seeks for itself through reorganized selling methods, it will soon be insolvent.

This chart shows the volume of original investment at its par value per year from 1923 to 1930 for eight corporations producing a total of 39,000,000 tons in 1930.

Including outstanding bonds as honest debts that should be retired at par, this chart also shows the shrinkage in market value of preferred and common stock from 1923 to 1930, while, though not uniformly, the combined annual output gained about 1,000,000 tons. The shrinkage in market value in these combined preferred and common stocks in this period amounted to about 61 percent. At the lows for 1930, not nearly so low as those for the current year, these particular combined preferred and common stocks declined 75 percent of the price at which they were originally sold to the public.

Chart 6



ORIGINAL INVESTMENT—MARKET EQUITY IN STOCK

THE REAL COAL PROBLEM

(*Continued from page* 20)

any degree of confidence in their ability to do anything sane and constructive for the bituminous coal or any other business. I don't care to see any industry or any business in which I have any investment or any interest put into the hands of men who have shown themselves to be as incompetent as that group down there today.

What we need to do is to recognize the fact that we have this job to do ourselves, quit looking to Washington for help, get busy and help ourselves.

Mr. Bradley has indicated to you some of the things that we need to do. I say to you there are many more that we can do for ourselves. The solution of this problem, whatever it may be, must necessarily rest with those of us who are in it and have to deal with it. If we can't solve it eventually there will be a group of other men in this business who can solve it. I am not a pessimist on the subject of its solution either. Personally I am satisfied it can be done. I don't believe in miracles. I don't think it can be done over night. I think that the solution, or the solutions, for there are several of them in my own belief, are on the way now. I don't believe there is any single blanket solution of this problem, for I doubt if any single measure would fit all districts and all conditions. I think in one field it may be worked out one way; I think in another field it is very likely to be done in another way, by the men there who are practical business men, who know their own condition, their own problem, who know what they have to do, and who have the confidence, the vision, the courage and the strength to do it.

I am not so harsh in my judgment either as to believe that what I am saying means purely and simply the savage survival of the fittest, because that economic law that I spoke of a while ago doesn't operate to keep alive the fittest in the best social scheme. It operates to keep alive those that are least fitted to survive from that standpoint. The companies today that have been selling coal the cheapest are the companies that are bankrupt. They have no responsibility any longer to the investors in those companies. The only responsibility they have is to the courts and the creditors. That is not sane and constructive competition at all, but that too is a condition that we men in the industry ourselves have to deal with.

Going back to another statement of Mr. Bradley's, coal today is not alone in its misery and trouble. A few days ago I spent two hours with the president of a great steel company in Pittsburgh, and he was outlining some of the problems that he was struggling with because, as he said, "It seems to me that the steel business is faced with some of the difficulties that you men in the coal industry have been working with for some time, and perhaps you can tell me something that I ought to do out of the experience that you men have had in the conditions that we now find repeated in the steel business" and he went on and outlined to me the same old story that we all know of sales below production costs, of competition of companies in the hands of receivers who have forgotten all about the interest of investors in the property, who are simply liquidating them for the benefit of creditors and their quotations on business setting a market level for certain steel products so that he had to compete with absolutely prohibitive prices. He had mills shut down and men idle and out of work, people whom he had furloughed and laid off, and he didn't know what to do about it all. When you compare the percentage of operations in the steel business today with coal, sick as we are gentlemen, I can tell you that we are a whole lot better off than the New Castle, or Youngstown, or Sharon, or Pittsburgh steel people today.

We have had a lot of our deflation. We have already journeyed a long way down that road toward the reconstruction of this business, and I have confidence enough in the future to believe that we will be able to work it out ourselves. If some ambitious and energetic politician in Washington wants to do something to save the country, I would like to see him start in and spend his energy in saving steel or agriculture, or any other business that may want to be saved in that way, because I don't believe in that kind of salvation.

Economies and Savings Through the Use of Mechanical Loaders

By H. B. Husband*

WITHIN the 10 years 1919 to 1929 the increased consumption of gas was 394 percent, of fuel oil was 75 percent, while the consumption of coal increased only 5 percent. We must seek an answer.

We should recognize that the producers of gas and oil are using every appliance, human and mechanical, to increase their efficiency with consequently decreased production costs. The coal business must meet this competition and any commercial competition from lower prices of competitive fuels. One of the essential means to this end is our ability to produce and load coal clean and cheaply enough to offset quality and price advantages claimed for other fuels.

The most practical and efficient agency to economically assist in producing clean coal is mechanical loading, which has long since passed the experimental stage, an evidence of which is that each year we find more coal loaded mechanically due to the fact that more and more coal operations are becoming convinced of their ability to produce clean coal and at lower production costs as a direct result of the use of mechanical loading.

Among the prominent savings in mechanical loading is accident prevention, which not only can be equated in production dollars and cents costs but also has a tremendous value in the human saving of limb and life.

From our own records less than one-tenth of 1 percent of our accidents in the past six years occurred in mechanical loading operations. During 1931 in our No. 2 mine, where mechanical loaders are operated, we had no accidents in connection therewith, while within the same year we had 20 accidents among those engaged in hand loading. The mechanical loaders loaded twice the amount of coal as was loaded by the hand loaders.

While mechanical loaders require supervision, just as do hand loaders, yet the mechanical loading supervision is more effective, due to its operation within a smaller area. We mine as much coal from two working places mechanically as we can and do from 20 places by hand loading. Much less track is required; the track, due to the limited area, is better and more economically maintained. For the same reason better power supply is obtained. Less timber is required, because the area is completely worked out in a short time.

Savings in operation and net earning result not so much from the *quantity* of coal loaded as from the *quality* of coal. In a limited mining area made possible by mechanical loaders, the cutting and shooting are controlled—we are, in most instances, able to cut out and load out the impurities before the place is shot—while a greater number of holes are required and more explosives are used than are necessary for hand loading, the better quality of coal produced justifies this additional expense. Coal does not have to be shot terrifically hard for mechanical loaders; in fact, we can and do get just as much lump coal in this way as is possible from hand loaders. Our interests are in producing clean coal rather than lump coal. In some areas it is necessary to produce lump coal in order to get clean coal.

In the last analysis it is not a question of whether or not we like mechanical loading; it is a question whether or not mechanical loaders give us cleaner and more cheaply produced coal amplified by the human safety factor—than is obtainable by hand-loading methods.

Our past six years' experience gives the answer positively "yes"! It makes of us a fully converted advocate of the many virtues of mechanical loading.

In spite of substantially curtailed production, our mechanical loaders are earning a net annual return of approximately 200 percent on the investment.

* General Manager, Fuel Mine Operations, C. & O. Railway Co.

THE REAL COAL PROBLEM

(*Continued from page* 19)

I have before me an analysis of some of the things that this commission can do under the bill from which I have just read:

"It can regulate the corporate structure of all corporate licensees and control their finances.

"It can prescribe the facilities which the licensee must have and use in the preparation of coal for the market, and prohibit the shipment in interstate commerce of coal that has not been treated or cleaned.

"It can regulate the mining community.

"It can regulate and control the company store.

"It can provide that labor must be paid weekly or at any other stated time. It can demand a measure of credit to labor for merchandise when the laborer is ill, on a strike, or otherwise without funds because of his failure to work, or where he is overdrawn with the company.

"It can provide that where there is a strike, the licensee shall not by judicial process or otherwise put the miner out of the houses of the licensee, say for three or six months, or for any other definite period.

"It can provide that the licensee must not interfere with any representative of the union contacting with the miners and inducing them to join the union, and will prohibit the licensee from discharging the men who join the union."

In other words, the commission can prohibit the licensee from closing down the mine in event the men join the union, and require the licensee to accept the decision of the miners in making it an organized mine.

"It can make such provisions in addition to what is contained in the bill, taking from the licensee any right or control over use of its premises for labor demonstrations thereon.

"It can regulate the salaries of executives and others, allowances for depreciation and depletion, and rate of return to the licensee.

"It can regulate the markets for the several sizes, and characters and qualities of coal, regardless of the demands of the consumer or the previous relations between the licensee and its customers.

"It can fix the prices for the several grades and sizes of coal shipped into each area.

"It can regulate production upon the basis of capacity, development, number of employes, or upon some other basis."

I will not continue to read all of the things that this commission might do. They have been published recently in the *Black Diamond*. As time goes on, if such a commission were created, we would probably be surprised to find how many more such things a commission could do than we ever thought it could at the time we contemplated its creation.

(*Continued on page* 42)

Economies to be Realized Through Proper Power Distribution

By Carl Lee*

Discussion by W. E. Wolfe †

THERE have been numerous articles written pertaining to the question of power supply for mines. Probably the majority of those in authority or responsible for the operation of the mines realize that an adequate power supply at the working face is desirable. Yet it seems that nearly every mine presents a new case to be solved, not only originally but each and every time there is a major change in working conditions. Also, as each mine develops and spreads out over a greater territory and as the entries become longer, there eventually arises the complaint of poor power at the face. This quite naturally occurs since the size in cross section required in the feeder lines increases in proportion as the distance increases. The doubling of distance calls for a doubling of size, hence doubling the distance calls for four times the total weight; therefore, at a given unit cost, four times the cost of feeder lines.

In this article an attempt will be made to evaluate some of the items involved in the economy of power supply. No attempt will be made to include a discussion of purchased versus generated power. Also, we will pass over lightly the case of shortage of generating or converting equipment. Frequent opening of a circuit breaker is readily observed and understood by all.

The final solution of the problem should not be based on the minimum requirements or the first cost of the feeders alone. The proper basis for consideration is the one which includes all items in the final cost of production. These might be outlined as follows:

1. Production losses due to slowing down of all types of main and auxiliary equipment, such as for cutting, drilling, loading, hauling, pumping, ventilating, etc.; or
2. Labor required to operate additional equipment necessary to keep up total production.
3. Direct power losses in the lines from the power supply to the load.
4. Maintenance and repair cost affected by low voltage.
5. Interest, depreciation, and other fixed charges on equipment and power lines.

If it were possible to place exact figures on the costs of the items in Nos. 1 and 4, we could arrive at a very close solution of the entire problem. However, the answers to those details have usually been more or less vague and, therefore, passed off as a matter of opinion one way or another.

If we assume additional equipment is not provided to make up for losses due to poor power, then we could reasonably assume that the loss of production is proportional to the loss of voltage and speed during the time that the equipment is actually working. Now the principal production equipment is provided with motors rated on a one-hour basis. These motors are good for approximately one-half their rating when operated on a continued load basis. Hence, we can assume that the average equipment when worked intermittently at a rate equivalent to one-half full load rating has reached safe maximum load.

If additional equipment is provided to overcome the loss of production due to low voltage, then the additional labor will be in proportion to the added equipment and the net result will be very much the same.

Since there are so many variables to be considered, and since these may have widely divergent values in different fields, it is thought that possibly a concrete example with all assumed conditions stated, and the final results figured out, might best bring out the nature of the problem.

First, it might be stated that a small load near by the source of power offers the simplest problem, while the other extreme is that of a large load at a considerable distance. Hence, our example will be one where there appears to be a question as to the dividing line between one or more solutions.

Assume a typical load in a mechanically loading section, 10,000 ft. from the power supply, as follows:

1 15-ton locomotive	150 hp.	2 men
6 loading machines	210 hp.	12 men
6 5-ton locomotives	300 hp.	12 men
3 7-ton locomotives	210 hp.	6 men
2 track-mounted mining machines	120 hp.	4 men
6 drills	12 hp.	6 men
	1,002 hp.	42 men

With an assumed loading of 50 percent of the rating above, the average load would be 501 hp., which, with rheostatic losses included, might be assumed to require 400 kw. delivered power at the load center.

Assume that there are 45 men involved in the section at an average rate of $5 per day, the labor cost would be $225 per day. Assume 2,000 tons per day, then the labor cost would be $.1125 per ton. From these figures, the following Table No. 1 is calculated. And, if as previously stated, additional equipment were added to make up for the drop in production, due to low voltage, then approximately or even slightly more labor cost would be added. This would cover item No. 2 listed.

Table 1

Assume 45 men at $5 per day used on production machines of load section. Assume loss of production at one-half of proportion of voltage loss below 275 v.

Operating voltage	275	250	225	200	137.5
Lost voltage	0	25	50	75	137.5
Labor cost per ton	.1125	.11815	.1238	.13365	.16875
Labor cost lost per ton	0	.00565	.0013	.01695	.05625
Working days		Dollars lost per year			
50		$565	$1,130	$1,695	$5,625
100		1,130	2,260	3,390	11,250
150		1,695	3,390	5,085	16,875
200		2,260	4,520	6,780	22,500
250		2,825	5,650	8,475	28,125
300		3,390	6,780	10,170	33,750

Table 2

Loss in Feeders for 400 KW. Load Delivered

Volts at load	275	250	225	200	137.5
Volts loss	0	25	50	75	137.5
Amperes	1,454	1,600	1,776	2,000	2,908
Kw. loss	0	40	89	150	400
Working days		Dollars lost per year =Kw.×8×.02×days÷efficiency (.82)			
50		$390	$866	$1,462	$3,900
100		780	1,732	2,924	7,800
150		1,170	2,598	4,386	11,700
200		1,560	3,464	5,848	15,600
250		1,950	4,330	7,310	19,500
300		2,340	5,196	8,772	23,400

* Electrical engineer, Peabody Coal Co.
† Clinchfield Coal Corporation.

The solution to the question of added repair cost is difficult, since the life of electrical and mechanical equipment working under poor power is not possible of exact determination. As the voltage decreases, the amount of work possible to be accomplished is reduced in proportion, so that it is not believed that the mechanical maintenance will greatly increase. However, the repair of armatures, fields, and controllers will rapidly increase as the voltage drops below the rating of the equipment. However, the losses in production and direct power losses in the lines will far more than outweigh the purely repair costs. These are assumed as follows in Table No. 3.

Table 5

Totals of all losses and fixed charges

Volts delivered	275	250	225	200	137.50	With sub-
Volts lost	0	25	50	75	137.5	station
Working days		Total costs per annum				
50	...	$19,953	$12,836	$11,546	$18,958	$5,223
100	...	21,007	15,097	15,217	31,617	6,437
150	...	22,060	17,358	18,888	44,275	7,650
200	...	23,114	19,619	22,559	56,934	8,864
250	...	24,167	21,880	26,230	69,592	10,077
300	...	25,221	24,141	29,901	82,251	11,291

Table 3

Assume electrical equipment in section as listed above, and further that one complete rewind of armatures and field coils costs $4,000.

Volts	275	250	225	200	137.5
Volts lost	0	25	50	75	137.5
Assume life of armatures working days	1,000	670	430	280	60.0
Cost per day for rewind	$4	$5.97	$9.30	$14.28	$66.67
Added cost above minimum	0	1.97	5.30	10.28	62.67
Working days		Added cost dollars per year			
50	.....	$98.50	$265	$514	$3,133.50
100	.....	197.00	530	1,028	6,267.00
150	.....	295.50	795	1,542	9,400.50
200	.....	394.00	1,060	2,056	12,534.00
250	.....	492.50	1,325	2,570	15,667.50
300	.....	591.00	1,590	3,084	18,801.50

The losses mentioned previously are reduced by good voltage conditions at the working face, but to keep the voltage up at the face costs money, and an evaluation of such costs and a comparison of the losses against the costs is where the principle of economics comes into the problem. Merely keeping first cost of feeder lines and generators down to the minimum possible on which to operate may be, and probably in most cases is, false economy. So now we shall consider the costs of keeping the voltage up to certain standards at the working face.

The largest item in extending power supply from a generator already installed is, of course, the copper or other conductor. Aluminum will compete when copper is relatively high. An estimate of the first cost of copper feeders is very simple with any assumed conditions. Annual interest and other fixed charges may be estimated for assumed or specified rates. Table No. 4 shows these charges which are fixed, regardless of days worked.

For the condition stated, it will be noted that for 50 working days, feeders to give 75 volts loss or 200 volts delivered, gives the lowest overall cost, while for 300 working days 50 volts lost or 225 volts delivered gives the minimum.

Reducing these figures back to costs per ton, and showing the results graphically, we would have curves between costs per ton and days worked, as shown in Figure I.

Fig. I

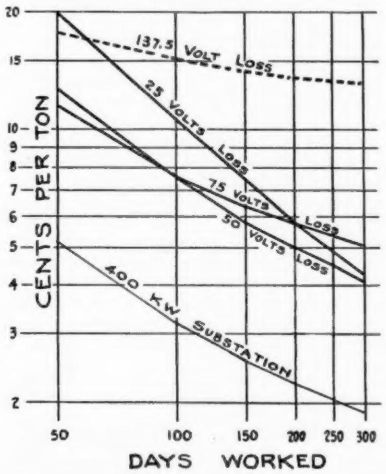


Table 6—*Cost of 400 KW. Substation*

The cost of an inside substation is made up of fixed costs plus variable costs, dependent on the distance. For our purpose, assume the following:

400 kw. set and board $12,000

Bore hole and room 4,000

Line (exclusive of copper) at 50 cents per foot. Copper at 15 cents per pound of size to give 5 percent line loss.

Distance, feet	Fixed cost	Pole line	Copper	Total	Fixed charges
2,500	$16,000	$1,250	$175	$17,325	$3,038.50
5,000	16,000	2,500	700	19,200	3,320.00
10,000	16,000	5,000	2,800	23,800	4,010.00
15,000	16,000	7,500	6,300	29,800	4,910.00
20,000	16,000	10,000	11,200	37,200	6,020.00

Table 4

Assume copper cost at 15 cents per pound installed, fixed charges at 15 percent per annum for 400 kw. load delivered at 10,000 ft. from generator.

Volts	275	250	225	200	137.5
Volts lost	0	25	50	75	137.5
Amperes	1,454	1,600	1,776	2,000	2,908
Size in circular mills	.....	13,700,000	7,600,000	5,720,000	4,530,000
Cost	.....	$126,000	$70,500	$52,500	$42,000
Fixed charges per annum	.....	$18,900	$10,575	$7,875	$6,300

Hence, under the assumed conditions, the most economical size of feeders would be such as to give between 50 and 75 volts total loss or an operating voltage on the motors of 200 to 225 volts. The feeder size would be about 5,500,000 cm. and 7,500,000 cm., respectively.

In the tables and figures, the results for 137.5 volts have been indicated. This has been done to show the smallest possible feeder size to deliver the power of 400 kw. to the face. At that point, one-

half of the power is lost in the feeders. Naturally, all equipment would be slowed down to a minimum, and whenever a momentary demand for greater power might be made, all equipment would tend to stall.

Since the size of feeder for this load and distance is very large, then the alternative of a substation suggests itself. Assume the costs of a substation as shown in Table No. 6.

Using the fixed charges as indicated and assuming 25-volt d. c. loss with corresponding costs and 5 percent a. c. line loss, the last column in Table No. 5 would be derived. Also, on Figure I, the costs per ton are indicated. Therefore, under all the assumed conditions, the substation would be amply justified. In fact, it shows a saving of 2 cents per ton for 300 days operation and 6 cents per ton for 50 days operation over the most economical size feeders.

In order to show more clearly the distribution of the costs on the feeders having 50-volt loss, which size appears most economical of the feeders alone, Figure II has been included.

Similarly, the distribution of the costs on the substation has been shown of Figure III.

Since there are so many variables in solving problems of economy in power supply, it is realized that to cover the entire range of probable conditions would require far too much time and space for this occasion. However, it is hoped that the foregoing will point the way to the solution of similar problems under the special conditions as may be found in the many mines.

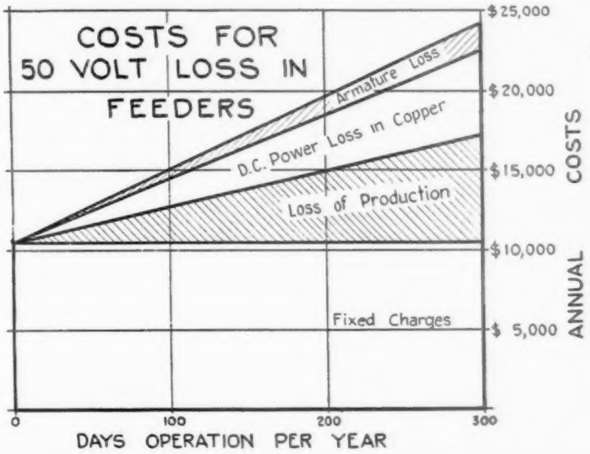


Fig. II

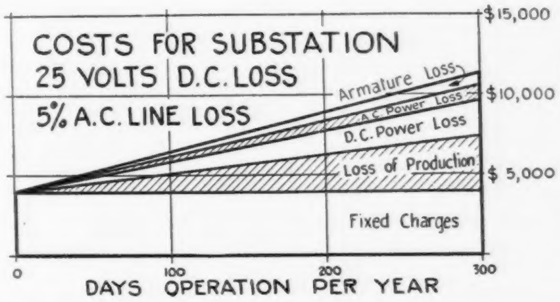


Fig. III

W. E. Wolfe—*Clinchfield Coal Corporation*

WE HAVE just heard the presentation of a remarkable paper on the subject of "Economies to Be Realized Through Proper Power Distribution."

We are indeed indebted to Mr. Lee for such a vivid picture of the probable loss the coal industry is standing for failure to have and maintain proper power distribution.

It would not be in keeping with the ideals of the coal industry to enter into a discussion of any of its operating phases without first giving consideration to safety.

A working knowledge of safety is the prime requisite to one's continuance in work of mining coal.

I mean, by a working knowledge of safety, one should study and know the inherent hazards of his installations and take necessary steps to guard them from his less-informed operator.

Safety, simplicity, and rigidity are factors coordinating the continuous movement of coal and are worthy of our most careful consideration, in all of our electrical and mechanical installations. Often it is necessary to sacrifice some electrical and mechanical efficiency in order to have these factors in the most practical degree.

The men in the power and mechanical department have an array of instruments which are necessary to intelligently analyze their problems. Some of these instruments can be used to a great advantage to your companies and to the other men in the organization by analyzing the hazards in equipment, electric exploders, etc., thus forewarning the men of the hidden dangers therein.

Let us remember that a car of clean coal is our finished product.

Roughly, the power cost per ton is about one-fourth the cost of loading a ton of coal in a mine car.

Owing to the diversified uses of power in mining coal, surely the electrical engineer has a wonderful opportunity to effect economies in the use of power.

The demand for coal is seasonal and likewise our power requirements.

As Mr. Lee has stated, each mine presents its own special power distribution problem, not only originally but later as the conditions underground develop. Sometimes the conditions do not develop as anticipated, due to the demand for coal, or the failure to fully prospect the seam prior to the projection, or changing the projection after the development has been started.

One of the problems in the economical use of power today is the readjustment of generating equipment, in order to get the most efficient load and by taking advantage of the compounding characteristic.

Taking Mr. Lee's concrete example, it is readily seen that sufficient voltage to barely move the required tonnage is not the most economical way to use power.

Less than the rated voltage is far more expensive in the total cost production than the cost to bring the voltage up to equipment rating, whether it be in additional feeder or additional generating equipment. A scheme that has been tried and found very satisfactory under present business conditions, from the standpoint of taking care of the peak demands without interruptions, closer supervision, less maintenance costs, less operator costs, saving of power in no load losses, and increasing the efficiency of converting equipment was to centralize the converting equipment, taking care of line losses to the limit with additional copper.

I wish to call your particular attention to Table No. 2 in Mr. Lee's paper, in which he shows the amperes of a 400-kw. load at various volts at load.

On a 275-volt system, with a drop of 75 volts, the amperes increase from 1,454 to 2,000, or an increase of 546 amperes. With a capacity load frequent interruptions may be expected, and we have a 150-kw. power loss.

If the distance from generator to load is reasonable, additional feeder will effect an economy well worth the investment.

Let us not always suppose that the drop in volts is due to insufficient feeder. The negative circuit is just as important as the positive, perhaps more so from the maintenance and supervision standpoint. Mine tracks have a dual purpose of carrying the principle return current and supporting the rolling equipment. The resistance of the return circuit should be no greater than that of the positive.

(*Continued on page* 42)

Economies of Treated Timbers

By Paul Weir*

Discussion by **A. R. Joyce** † **Fred Graf** ‡

THIS Cincinnati meeting of the American Mining Congress has to do largely with the modernization of the coal industry. Timber utilization is very properly one of its important subjects. Any discussion involving timber utilization leads quite quickly to the preservation of timber from decay or rot. The things which I will attempt to bring out in this paper are of a general nature and are not necessarily confined to our own experience on our own properties. They involve no technical discussions of the preservatives employed or of processes. The art of wood preservation may be likened to the art of mechanical loading in that both are thoroughly established and are out of the experimental stage. The problem consists in the economical application. This economical application comes from close cooperation between coal operators, timber producers, and timber preservers.

Rot in wood is caused by fungi or parasitical plants that grow in timber and feed on the wood substance. Preservatives operate by poisoning the food supply of these plants. Other things being equal, the preservative used is the one which will accomplish this poisoning in the cheapest manner. The goal of timber utilization is to have timber wear out instead of rotting out. In some temporary work, it is more economical to permit rot to claim the timber. In permanent or semipermanent work it is undoubtedly true economy to preserve the timber against rot. The choice between preserving or not preserving is one of dollars and cents.

In general, coal operators have not come to a realization of the savings in treated timbers. In times gone by they have been frightened by prices asked for the treated product. They are accustomed to purchasing raw timber on specifications which imply a rather liberal inspection policy. The tolerances permitted have been quite large by comparison with those used by the railroads, who are the largest customers that timber-preserving companies have. These preserving companies accustomed to railroad tolerances and inspections base prices on mine timber accordingly. Frequently this has resulted in mining companies paying for sizes that they did not need or desire.

The treating of crossties has permitted the railroads to use nondurable woods as a cheap and abundant source of supply. Woods classed as durable as opposed to nondurable are heart of white oak, heart of long-leaf yellow pine, redwood, black cypress, and cedar. If the original mechanical strength of a tie or timber is adequate, treating will prolong that strength for a long period of time. There is no necessity for anticipating decay, and consequent impairment of strength, by using oversize timbers. The usual practice in many mines where timber rot is a factor consists in using sizes of timber not called for by actual conditions. Expected rot is taken care of by increasing sizes rather than by using minimum sizes and treating these sizes. When it is remembered that the cubical contents of a round bar or leg varies as the square of the diameter and that cost varies directly with the cubical content, the importance of this factor will be realized. In many cases raw 10-in. tip legs could be replaced by 7-in. tip-treated legs. The cubical contents of this treated leg is less than one-half of that of the raw leg. It is safe to assume that the strength of the 10-in. raw leg will not exceed that of the 7-in. treated leg after a comparatively short space of one and one-half years to three years under ordinary mine conditions. Likewise, the size of raw ties is frequently greatly increased to take care of expected deterioration. Rail bearing surface beyond need is provided. Thickness in excess of actual spiking requirements is specified. For heavy-duty mine service, a 5 by 7 treated tie in many cases is preferable to a 6 by 8 raw tie. The difference in size alone overcomes quite a large part of the difference in cost between treated and untreated ties.

Mention has previously been made of tolerances in sizes. Few mining companies hold to a rigid inspection. Those who do, get exactly what they pay for, but at an increase in cost compared with those whose inspection is based on average appearance. Without going into the merits or faults of either system, some things can be said. A timber producer who is accustomed to producing on close tolerances will closely approximate the specified tip size of a leg. A producer who has never been held to close tolerances will permit a wide variation in tip sizes with a considerable percentage of his output undersize. Treated timbers usually are produced by established companies whose main volume comes from railroads, consequently the average size of treated timbers produced on the same specification will exceed that of the raw timber. This is especially true of hewn ties. Firm specifications with strict inspection and smaller tolerances will permit in many cases the decreasing of nominal sizes of timber without decreasing the average size. In comparing costs of timbers, whether raw or treated, this factor of tolerances must be considered for the reason that it can easily explain variations of 10 to 20 percent in quotations.

For the past few years, coal operators have had no occasion to anticipate their requirements of raw timbers. There are more unemployed timber producers than there are unemployed miners. Treated timber presents a different picture. In order to keep down the cost, the timber must be peeled and must be air-seasoned before and after treating. This reduces to a minimum the freight charges and handling charges, because all excessive moisture is eliminated and treating is facilitated. It is obvious that coal operators must anticipate their treated-timber requirements months ahead if they wish to get the best product at the lowest possible price. Standard specifications and sizes for the mines of one company or for a group of companies, together with their anticipated requirements for at least six months in advance, constitutes a program which is necessary if the cost of treated timbers is to be kept at an absolute minimum. This information in the hands of a commercial timber treater will permit him to purchase advantageously and to deliver when needed the proper sizes correctly treated. If this commercial timber treater operates his own sawmill, he can convert some of his waste materials into sizes of timber which can be used at mines. When this can be done he is in a position to pass on to the coal operator a considerable saving.

The selling price on all raw timber is based to a large extent on cubical contents of the stick plus the labor of peeling and hewing or sawing. Freight on shipments of timber is based on weight, which is a product of cubical contents. Cost of treating is based on cubical contents. Cost of unloading and loading is based largely on weight. It is extremely desirable to reduce to a minimum the sizes of treated timbers used. A careful engineering study of conditions at any mine will reveal those timbers the size of which might be reduced without impairing their fitness for the work to be done. This study should take into consideration the tendency to use oversize raw timbers to offset the weakening effect of rot. It should also include the question of tolerances on inspections. If these things are done and results are carefully analysed, it will be found that the delivered cost of treated timbers is surprisingly low.

There is a deplorable lack of accurate data on the service life of both raw and treated timbers. Inasmuch as the economics of timber costs are based on service life and the data on this life is incomplete, we can only arrive at general conclusions at this time. In arriving at these conclusions, much weight can be given to the well-known experiences of

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† Joyce Watkins Company.
‡ Union Pacific Coal Company.

this country's railroads. Bulletin No. 33, "Methods and Costs of Treating Mine Timbers," published by the Carnegie Institute of Technology, gives in detail the results which have been obtained by various railroads by treating their ties. In Chapter V of this publication the results of tests made by the Chicago, Burlington & Quincy Railroad are given. The tests showed the average life of untreated ties to be from about 3 years in the case of nondurable woods to 8.5 years in the case of white oak. These same tests showed the average life of treated ties had not been reached after 17 years. The oldest test in coal mines of treated timbers dates back to 1906. At that time the United States Forest Service commenced tests in the Silver Creek Colliery of the Philadelphia and Reading Coal and Iron Company. Eighty-eight percent of the original timbers listed for test in Bulletin No. 33 were still in place and in good condition after 20 years of service. In September, 1931, Galen Wood, chemical engineer, made an additional report on these tests. A quantitative analysis for zinc chloride was made by Mr. Wood on five of the original timbers. He found from two to five times the amount of zinc chloride needed to prevent decay still remaining in the timbers after 25 years of service. Every mining company, whether using raw or treated timbers, should keep a service record of some kind. The February issue of THE MINING CONGRESS JOURNAL presents an article by R. M. Wirka, entitled the "Why and How of Mine Timber Records." Definite suggestions are made for compiling records. Date nails should be used on all treated timbers. The simplest plan is to have the treating company apply the nails.

When the service life of raw timber and treated timber is definitely known, the choice between them is a matter of calculating annual charges. To the prices of each, f. o. b. mines, must be added the cost of unloading, the cost of storing, the cost of delivering, the cost of removing old timber, and the cost of placing the new. Frequently there will be found a saving in these items in favor of treated timber. The American Railway Engineering Association uses the following formula for calculating charges:

$$A = \frac{Pr\ (1+r)^n}{(1+r)^n - 1}$$

Where A = Annual charge
P = Amount of initial investment
n = Average life of timber
r = rate of interest expressed decimally

Based on 6 percent interest rate, the annual charges due to initial expenditures of $1 are as follows:

1 year	1.060	15 years....	.103
2 years....	.545	16 years....	.099
3 years....	.374	17 years....	.095
4 years....	.289	18 years....	.092
5 years....	.237	19 years....	.090
6 years....	.203	20 years....	.087
7 years....	.179	21 years....	.085
8 years....	.161	22 years....	.083
9 years....	.147	23 years....	.081
10 years....	.138	24 years....	.080
11 years....	.127	25 years....	.078
12 years....	.119	26 years....	.077
13 years....	.113	27 years....	.076
14 years....	.108		

The use of this formula and table can be illustrated by a specific problem. The cost of raw 5 x 7-6 ft. 0 in. hewn oak ties is 35 cents, f. o. b. mine. The cost of 5 x 7-6 ft. 0 in. sawed oak tie treated with zinc chloride is 60 cents, f. o. b. mine. The additional charges to be added for handling and placing is 83 cents per tie. The life of a raw tie is three years. Its annual charge is $1.18 x .374, or 44.1 cents per year. The initial expenditure on a treated tie is $1.43. If this treated tie had a life of only four years, its annual charge would be $1.43 x .289, or 41.3 cents per year. An additional life of only one year in this particular case covered the increased cost of a superior tie treated with zinc chloride.

Actually the mechanical strength of the treated tie will be preserved 10 to 20 years. In so far as coal mines are concerned, it will be found that the cost of labor of replacing timber sets or ties is at least equal to the cost of the treated timbers. In most cases it exceeds the cost of the materials. Railroads with men working at lower scale of wages in the open find the use of treated ties profitable. The labor cost of replacing a railroad tie is taken by them to be one man-hour. It is conceivable that the cost in coal mines is greater because of artificial illumination and ventilation, and in addition the close quarters in which miners must work. The savings which accrue through the use of treated timbers are due largely to the savings in the labor cost of replacement.

L. C. Drefahl, in the 1930 Proceedings of the American Wood-Preservers Association, says: "It has been estimated by Government engineers that of the 2,400,-000,000 bd. ft. (200,000,000 cu. ft.) of timber used in the mines annually, 5 to 15 percent should be treated, or approximately 250,000,000 bd. ft. (20,000,000 cu. ft.). In 1928 about 9,600,000 bd. ft. (800,000 cu. ft.), or less than 5 percent of this prospective amount, was reported as treated, mostly with zinc chloride and creosote." He continues, "The amount of treated timber used in mining is obviously only a fraction of the possible annual requirements."

I am giving you these figures to show that the mining industry has not grasped the savings in treated timber in the manner that the railroads have. It is possible to obtain a conception of the annual savings which could be effected in the mines of this Nation by making certain reasonable assumptions. The cost of treated timber when nondurable woods are used is approximately 50 cents per cubic foot. The cost of raw timber is probably 60 percent of this, or 30 cents per cubic foot. The average labor cost of replacing timber sets and bars will exceed the cost of treated timber, but let us assume that they are an equal. This means that the labor cost on both treated and raw timbers is taken at 50 cents per cubic foot. The average life of raw timber does not exceed four years, and an assumption on that basis is logical. The average life of treated timbers exceeds 16 years, but we will use that life as typical.

The cost in place of raw timbers on this basis is 80 cents per cubic foot, and of treated timbers $1 per cubic foot. The annual charge per cubic foot on raw timbers is 80 x .289, or 23.12 cents. The annual charge per cubic foot on treated timbers is 100 x .099, or 9.9 cents. The saving is the difference, which is 13.22 cents per cubic foot. These calculations apply only to the 20,000,000 cu. ft. which Mr. Drefahl states should be treated. Translated into savings per ton of coal production, it amounts to approximately one-half cent.

Undoubtedly this is a conservative estimate. The coal mine uses for which treated timber should be considered are many. Underground they include shaft and slope timbers, permanent and semipermanent timber sets, ties and switch ties in permanent and semipermanent track, air-course timbering, mine-car lumber, and rock-dust barriers. On the surface are permanent structures, such as buildings, tipples and head-frames, railroad ties, and poles for power lines.

The efficiency of all preservatives depends upon their toxic values. The oldest and best established ones are creosote and zinc chloride. The use of either of these or a combination of the two will cover practically all conditions. Inasmuch as zinc chloride is soluble in water, an amount larger than the usual one-half pound per cubic foot should be specified when used in wet places. Likewise the use of creosote in dry places underground might be questioned, not because of its inflammability but because of the dense smoke it produces if timber which has been impregnated with it burns. Creosote and zinc chloride are by no means the only suitable preservatives. They do have the advantage of wide use over a long period of time, consequently more is known of their preserving qualities. A full discussion of various preservatives is given in chapter 2 of Bulletin 33, "Methods and Costs of Treating Mine Timber," published by the Carnegie Institute of Technology.

In a previous paragraph mention has been made of the tendency to use oversize timbers. Obviously it is impossible to definitely determine the loads which timber sets will be called upon to bear. The size of crossbars must be determined by experience. In the average bituminous mine, more bars fail because of rot than because of excessive loads. While calculations for the size of crossbars means little, calculations for the size of supporting legs are indicative if not conclusive, where no side pressure exists. In the use of treated timbers where the mechanical strength is preserved indefinitely, there is no justification for supporting crossbars with legs of a size which will withstand two or three times the breaking strength of the bar. This statement applies to flat workings. In our own mines, after a thorough investigation, we made a substantial decrease in tip size of legs. We are now using 6-in. and 7-in. tip sizes in place of 8-in., 9-in., and 10-in. tip sizes.

Mention has been made of cubical contents in several preceding paragraphs. Generally speaking, where timbers, raw or treated, move to a mine by railroad haul, the price is set on a cubical content basis, which is another way of saying weight. Freight is based on weight. Treating costs are based on cubical contents. The cubical contents of sawed ties or lumber are easily calculated. In the case of round bars or legs there is used, the American Wood-Preservers Association formula which is:

$$\text{Contents}\ \frac{D^2+d^2+Dd \times 0.2618 \times L}{144}$$

Where D = Butt diameter
d = Tip diameter
L = Length

At present in commercial treating plants in our district the cost of applying ½ lb. of zinc chloride per cubic foot is 12 cents on sawed materials and 16 cents on round sticks. These prices include seasoning before and after treating, also loading into cars for shipment. The higher price on round timbers is due to the fact that the capacity of the treating cylinder is decreased. Square or rectangular pieces take up less space. Prevailing prices on sawed hardwood ties treated with zinc chloride delivered to southern Illinois mines is approximately 40 cents per cubic foot. A 5 x 7-6-ft. 0-in. hardwood tie costs approximately 58 cents. The prices on treated round pine timbers is approximately 43 cents per cubic foot delivered to southern Illinois points. The price on treated pine ties is approximately 3 cents per cubic foot less than hardwood.

It is well known to every mining man that the forces of nature and compound interest operate 24 hours per day and 365 days per year. This same statement is largely true of the parasitical plants which feed on wood substance. Rot proceeds with the same speed and sureness as compound interest; in fact, rot is thought by some to be accelerated during shut downs. During these trying times of intermittent operation, maintenance costs show a substantial increase. Treated timbers and ties are a practical means of helping to keep down this maintenance cost.

In this paper I have attempted to bring out those things which seem to me to be questions which arise in the minds of coal operators when treated timbers are discussed. My approach has been through the practical rather than the technical. No coal operator can overlook savings of any character. The economy in the use of treated mine timbers is worthy of consideration by all.

A. R. Joyce—*Joyce Watkins Company*

THERE was a time when the economists of the world were seriously concerned with the problem of whether it would be possible to produce enough grain, coal, steel, and other basic commodities to take care of the growing demands of the population.

In the last quarter of a century, the application of power in the form of steam, electricity, and gasoline engines, has made it possible to develop production capacity in excess of the current demands for consumption. There was a time in the coal industry when the pressing problem was one of maximum production but today the problem is rather the proper balance between the largest possible production that can be sold and the cost of that production.

While there are some mines operating on a continuous basis, this is not true of the industry as a whole and the problem of management is in modernizing the mines which can be worked profitably and in abandoning those properties that are no longer required.

The elimination of decay in mine timber through wood preservation, is one of the important factors in reducing the cost of mining coal. Mr. Weir has pointed out that the cost of a 5 x 7—6′ hewn, untreated oak mine tie, is $1.18 in place and the annual charge against this tie on a three-year basis, is 44.1 cents per tie per year. He then showed that a treated tie having a cost in place of $1.43, would be a profitable investment if it lasted only one additional year.

If we assume further that the treated tie will last an average of 16 years, the annual charge is 14.1 cents, or an annual saving of 30 cents per tie per year, compared with the untreated tie. Figuring the ties will be spaced on 21-inch centers, there will be 3,000 ties per mile and at an annual saving of 30 cents per tie, this figures $900 per mile of maintained track.

In addition to this annual saving of $900 in the direct cost of maintaining track, there are the added benefits of increased safety and more dependable main haulage with its freedom from delays and shutdowns.

The direct saving due to the use of treated main haulage ties in a mine that is currently maintaining 10 miles of permanent tracks, would be $9,000 per year.

In a similar manner, the untreated three-piece timber sets figuring two 7-ft. legs and one 12-ft. bar in 12-in. round timber, would amount to approximately 21 cu. ft. which, at a cost of 80 cents in place, would figure $16.80. If we figure that two 7-ft. legs with 7-in. tip and one 12-ft. bar with 10-in. tip of treated timber, will give a satisfactory result due to the elimination of decay, this three-piece set would contain approximately 12 cu. ft. of timber and would cost in place, $12.

Using Mr. Weir's figures of four years for the untreated set, the annual cost per set would then be $16.80 \times .289$, or $4.86 per set per year. Figuring the treated set at 16-year life, the annual cost would then be $12 \times .099$, or $1.19 per year, or a saving in favor of the treated set of $3.67 per year.

Under relatively heavy timbering conditions, assuming 1,000 timber sets per mile, this would be an annual saving of $3,670 per mile of permanent opening per year. This does not take into account the savings due to increased safety and elimination of delays.

One fact becomes increasingly important as the competitive demand for fuels make it more difficult to obtain what has previously been considered normal running time because, as the volume of coal decreases, the costs increase as the volume diminishes which further emphasizes the importance of using treated timber where decay is a factor in its service. When the mines are shut down and the ventilation is cut to the minimum, decay takes place with increasing rapidity in the untreated timber.

The experience of the railroads in the use of treated timber is conclusive and the mines should have no difficulty in taking advantage of the railroad experience when specifying timber for use on the surface.

One prominent railroad engineer has figured the railroads are now saving $145,000 per day, due to the use of treated ties. This is a substantial sum of money but the return to the coal mines will be relatively greater than it has been to the railroads for the reason that in the mines the cost of labor to put the timber in place, is so much higher than it is on the surface.

Mr. Weir has brought out this fact emphatically and it is evident from the interest which the mining industry is concentrating on the mine timber problem, that it will not be long before the mines are receiving the full benefit of the lower cost of production due to this cause.

Fred A. Graf—*Union Pacific Coal Company*

THE paper of Mr. Weir has mainly dealt with the savings which can generally be accomplished by the use of treated timber underground and he comes to the conclusion, that "The economy in the use of treated mine timbers is worthy of consideration by all."

Such a statement leads naturally to the question of each individual operator, whether in his mines savings can be made through the adoption of treated timber, how substantial these savings will probably be and what he can do himself, to make these savings as substantial as possible under his particular conditions.

Based upon experience, I will try to show a way, how an investigation can cheaply and efficiently be carried out.

As mentioned in the previous paper, firstly a careful engineering study of any mine is essential, which should bring out the places in the mine, at which rotting instead of wearing out of timber prevails and at which oversized timber is used to offset the weakening effect of the rot, stating finally the proportion of this timber compared with the total timber consumption of the mine.

Guess work should be avoided as much as possible in this study, but due to the usual lack of accurate data on the service life of timber in the mine and the uncertainty of roof pressure, etc., arguments will usually be raised, as soon as this study is completed. It might be kept in mind, therefore, that it never pays to treat the following classes of timber:

1. Timber confined to short service;

2. Timber on places, where heavy roof pressure occurs;

3. Timber on places, where rot has not been observed.

This leaves in general only a small proportion of timber used in question for treatment and I know mines, where only the ties have been left for consideration. Some others, however, had a surprisingly high amount of props, crossbars, cribs, etc., which answered the necessary requirements also.

As soon as the total amount of timber for treatment in question has been calculated and the sizes, reduced to a minimum, have been properly stated, a cost calculation has to be made.

For this I am in favor of another formula, than the one mentioned in the previous paper. I think, that the operator wants the answer for either one or the other of the following questions: "What price for treated timber is the limit for their economic use in my mines?" or "How much longer has the treated timber to stand up, than the raw timber, in order to render savings?"

The answer for both questions is given by the following formula:

$$A \times \frac{1}{P} \times (H+L) = A \times X \times (H+L+T)$$

In which: A = Total amount of timber in question for treatment (cubic feet);
P = Average life of this timber when raw;
H = Average timber cost per cubic foot;
L = Average labor cost for replacing one cubic foot of timber;
X = Average life of treated timber;
T = Treatment cost per one cubic foot.

The left side of this equation gives the present annual expenditures for replacement of timber, which has been taken in consideration for treatment. On the right side of the equation either X or T can be the unknown factor, which means, that either the efficient limit of expenditures for treatment can be figured, when the approximate lifetime of treated timber is known, or the time, which the treated timber has to stand above the time of raw timber, when the costs for treatment are known.

This formula has been found a great help for all cost calculations on treated mine timbers. It covers in an average all necessary items except the savings originating from the use of oversized raw timber, which have to be figured separately.

This formula permits also the calculation of one case, which has not been mentioned yet: the installation of a treatment plant by the mine operator himself. There are many mines in this country, where a commercial treating plant is not advantageously located, or where unloading and reloading of timber at a certain point for treatment, or where the freight rates would raise the dead expenses for treated timber too high. In such a case a plant at the mine itself should be considered and the above mentioned formula renders the possibility to solve the cost angle of the matter by answering the question, how much one can allow as treatment cost per cubic foot, in order to still save money.

When figuring on a treating plant at the mine, especially in comparison to delivered treated timber, the vacuum pressure process should always be considered. The other two processes, to either paint the timber with the preservative or to dip the timber into a vat for a certain time have no penetrating effect and are not adequate to modern science. Only the vacuum pressure process assures penetration for almost all kinds of lumber, maybe except oak, about which opinions differ. Technical design of such a plant as well as its operation is simple and it requires only one man for its operation.

Distance from commercial treating plants should therefore be no reason to abandon consideration of treating mine timbers, when their usefulness is assured according to the above mentioned calculation. Under ordinary conditions \$5,000 to \$6,000 will cover the expenses for such a plant, the depreciation rate of which being usually around 10 percent.

Surprisingly often the installation of a treating plant at the mine will prove cheaper than the delivery of treated timber, especially where a company operates more than one mine. Preference should be given then to it without hesitation, since it offers additional advantages, which mostly offset the difficulties occurring through the necessity of greater care in foreseeing the consumption of treated timber.

One of these advantages is, that the building department of the company and independent contractors in the vicinity are usually glad to have an opportunity to treat lumber of any kind, such as poles, fences, window shutters, etc. Treatment by odorless and paint-taking preservatives has been proven more and more economical for building purposes.

The greatest advantage, however, is the opportunity for the mine operator, to choose his own preservative.

In the previous paper the statement was made, that the use of either creosote or zinc chloride or a combination of the two will practically cover all conditions. I do not entirely agree, that these two will answer all questions. Creosote treated timber has severe disadvantages for its use in mines, whether dry or wet, although it is low priced and has high toxic value. Mr. Weir has already mentioned some characteristics, which make it unfit for dry places. To these the penetrating smell could be added, which causes a deterioration of the air and veils mine fires. Its most serious disadvantage, however, confined to dry and wet places as well, is its property to cause serious and long-lasting inflammations of the skin, when touched while perspiring. Respect for life and health of the employes should forbid its underground use entirely.

I am also not so much in favor of the zinc chloride treatment for mine use, although its results in dry places are thoroughly satisfactory.

The toxic value of this preservative is quite low and comparatively large quantities have to be applied, to assure reasonable efficiency. Its greatest disadvantage is its water solubility, which has been mentioned in the previous paper and which can only be overcome by the application of larger amounts of preservative per cubic foot for wet places.

This, naturally, is not very economical, because it requires either a distinctive distribution of treated timber for wet and dry places or an over-treatment of all timber.

The solubility has another disadvantage, which is more serious. Many tests have shown, that leaching of zinc chloride treated timber develops free hydrochloric acid, which affects unfavorably all iron parts and weakens the fiber of the timber, especially on those places, where it is touched by iron.

Mine ties at wet places, therefore, can not be efficiently treated with zinc-chloride and considering the great proportion of ties bound to become wet on account of sprinkling, etc., the efficient use of zinc-chloride for underground treatment can generally be questioned.

For operators, considering a treatment plant at the mine the additional disadvantage of unfavorable effects of the zinc-chloride on the steel parts of the plant has also to be mentioned.

Among all the other preservatives known (and there are plenty) only the so-called "Wolman Salts" seem to answer all necessary requirements for mine timbers. They are manufactured by the American Lumber and Treating Corporation. Their toxic value is extremely high, the treated timbers are entirely odorless and can be painted. Wolmanized timbers have been tested as less inflammable than raw timber and if burning, they develop no dense smoke. Their water solubility is extremely low, they show no effect on iron. Unfavorable effects on the health of the employes have not been detected. The treating solution, which can be applied hot or cold, penetrates thoroughly, it also enters the already affected parts of the wood, which by creosote treatment will be only surrounded. Their price, based upon their value for underground service, compares favorably with all other preservatives. All this has been proven since 1914 in Europe under the most rigid tests.

Since commercial treating plants in this country do not use Wolman Salts for treating timber yet, because their superiority is mostly confined to the rigid conditions in mines, the choice of the right kind of preservative can be charged as an advantage for the installation of a treating plant at the mine.

But whether plant located at the mine or not, Wolman Salts or any other preservative—there is no excuse under the present coal mining conditions for disregarding savings, which can so easily be figured in advance, as the ones through treating the timber.

In earlier days the objections of the men in charge of the daily operations underground, who feel annoyed by being forced to state in advance their demand for treated timber and dislike the inconvenience of the more complicated timber distribution might have been reason enough, to abandon the idea, but under the present severe conditions every chance for lowering production costs has to be watched. Experience has shown besides, that the three inconvenient requirements, which are connected with the introduction of treated timber, firstly the necessary more rigid inspection of timber purchased, also peeling and air seasoning, secondly the more complicated organization of underground distribution and finally the requirement of a service record, have led to additional savings, which can indirectly be charged as advantages for the introduction of treating.

There is in fact only one argument by which the usefulness of treated timber could be questioned: i. e., the increased use of steel props and steel arches for supporting those places, at which otherwise treated timbers would be used. But it is safe to say, that the yielding properties of wood, its easy handling underground and its universal usefulness combined with its low price render advantages, which makes substitution difficult for many years to come.

Economies of Arc Welding

By A. E. Steiger*

WHEN one undertakes the study of any certain phase of industry it is always interesting and beneficial to go back to the pages of history to learn, if possible, the progress made and the difficulties encountered in its development.

Like many other of the highly essential factors now found in modern industry, there is little or nothing recorded in the archives of history which would actually indicate the origin of welding, either with reference to time or place.

It would only be reasonable to assume, however, that welding did not precede the advent of metals. We naturally conclude, then, that the art of welding was developed in a crude fashion soon after primitive man learned to make iron. Undoubtedly the early history of welding is closely related to the history of metals.

The date and manner of discovery of iron is entirely problematic. Historians have arrived at various conclusions as to the manner and time of its discovery by ancient people. Research of those interested in archaeology would lead us to the belief that the discovery of gold, copper, and bronze preceded the discovery of iron.

However, there is credible proof that the inhabitants of the ancient Sumerian and Accadian cities put iron to extensive use as far back as five thousand years before Christ. These cities were located on the eastern shore of the Mediterranean Sea in what is now the country of Turkey. Research has led us to the discovery of the early use of iron in widely separated countries of the world.

Like the use of iron, the art of welding has progressed unnoticed during the centuries until today it is an indispensable factor to our industries. The past decade has witnessed many major developments in the welding field. Industries in general have taken a new attitude toward accepting this method as a dependable construction tool.

It is only reasonable that we follow the development of iron and steel for it forms the basis for arc welding. With the development of the Bessmer and Martin processes for making low carbon steel a new era dawned in industrial progress. These two processes were developed during the nineteenth century and really mark the dawn of the Steel Age.

Today much thought and consideration is being given the possibilities in the welding field and no angle or problem is too small to escape attention. Old methods are being supplanted by new and improvements are being made with the sureness which brings perfection.

We have three General Electric, 300 amp. welding machines in service at our plants.

Considerable welding has been done on the lower bases of our large stripping shovels. Anyone familiar with strip mining will realize that the failure of a structural in the base is one of seriousness and will readily know that such an incident can halt production if the conditions are adverse.

* General Superintendent, Pyramid Coal Co.

One occasion which I call to mind was that of a main girder breaking on one of our stripping units. Had we not been equipped with welding machines at our plant, it would have been necessary for us to shut down until such time as this girder could have been replaced. Fortunately, with the aid of the arc welding machines we were able to make the necessary repairs without retarding production. This failure was an open fracture in the main girder on the lower base. By relieving the weight of the revolving frame with jacks, we were able to repair the girder in place. After the welding was completed in the original plate we then re-inforced the weld with plates riveted in place. As an added precaution the edges of the plate were then welded. We find it practical to weld about 50 percent of the outside radius of the re-inforcing plate. In order to provide flexibility we make it a practice to weld up 4 in., then leave 4, making the weld completely around the plate. This was a permanent repair.

Another repair job which we encountered and in which this method played a major role was that of a breakdown on another of our units. This time the break occurred at the lower end of the right back leg, supporting the boom, dipper handles, and A-frame. The hitching to which the legs are attached is constructed of steel castings, riveted to the main deck of the revolving frame. We experienced unlimited success in this repair job by the application of welding. The point where the break occurred was almost inaccessible. The repairs were made, however, with a loss of only 18 hours running time. Had we not have had access to a welder it would have been necessary for us to renew the broken part which would have taken at least six days. We would have been forced to remove the ballast from the machine, water tanks, and some other braces in order to make the repairs. We accomplished the repairs by welding the casting in place which supports the back leg and re-inforcing with a 2-in. round iron, placed around the casting. This repair was made about 18 months ago and was a permanent repair job.

The greatest advantage of arc welding to us is that by its use we can make repairs without removing the parts which have failed. This eliminates the necessity of shutting down the unit for a great length of time, which to any industry, means a material money loss. Another valuable feature is in making these repairs we reclaim and prolong the life of numerous parts indefinitely.

We have made quite a number of repairs to large sheave wheels such as point sheaves for our large shovels, some of which have failed shortly after being put in service, due no doubt, to stresses set up in wheels when casted. The wheels being cast steel, the fracture usually develops in the spoke where it intersects either the rim or hub. In making these repairs we use the arc and weld up fracture to original form and re-inforce by laying an extra piece of metal, either round or flat, where it will fit best and weld this in place over the break. We have two such sheaves which have been repaired in this manner that have been in service at length and we feel we will experience no further trouble from these sheaves in the same place. To replace new would have cost considerable money and about four days running time in each instance. We have also repaired large gears with the same success.

We have found arc welding a dependable tool in building up drainage pump foundations from structurals. We use it in assembling almost exclusively.

In the event of breaking out a tooth in a gear which shows little wear we find that we can reclaim these gears by drilling and putting in studs of mild steel, welding together in a mass with carbon steel electrode and machining to proper shape. Many gears have been repaired in this manner and given us an additional 50 percent service or better.

We use the welder in making repairs to our dipper handles on our large shovels where fractures occur in the I-beams or angles which make up these handles. We weld the fracture and reinforce, as our experience has led us to the belief this is the best way to do the job. These repairs are made with handles in place, eliminating the time and expense of removing.

In repairing our dippers and dragline buckets which are constructed of steel castings, steel plates, or manganese we use such electrode as may be required for the kind of metal contained in the broken parts. We have had very little reason for complaint in connection with repairs of this nature.

We use the arc extensively in building up dipper teeth for our large stripping units. These teeth are steel forged. After they are worn down we build these teeth up, using a high carbon electrode for a base and covering it with a layer of standard hard surfacing electrode. Afterwards we heat the teeth to a degree sufficient to relieve all stresses set up by welding. We find these teeth can be built up as many as three or four times and made to move approximately as much yardage each time as they did originally.

Arc welding is used extensively in making repairs to our tipple, such as welding broken conveyor pans without removing them, building up crusher teeth, and repairing broken beams and structurals. It is also used on our locomotives in welding in new flue sheets, welding up fire cracks and repairing the frames. We have also found it economical to apply it to repairing of pipe lines and water supply system, and welding together waste parts of drill hole casing, making them to suitable lengths for use.

We consider arc welding practically indispensable to the maintenance of our operation. We have always found in it a dependable tool, one in which to place utmost confidence. In summing up, we believe the arc weld is one, if not the most important of repair tools. When properly handled its performance is efficient, economical, and practical.

Oxy-Acetylene Welding and Cutting in Coal Mines

By E. S. Wade*

EQUIPMENT and tools made of metal are used in every phase of coal mining, from breaking down the coal to loading it in cars for shipment to the consumer. For their installation, maintenance and repair, there is continual need for cutting, joining or forging the metal of which they are made. The most useful and versatile means by far for doing this has been found to be oxy-acetylene welding and cutting. With welding and cutting equipment, it is possible not only to sever iron and steel or join metals, but to supply heat for bending, riveting, forging, annealing, tempering and case hardening in the blacksmith shop. The cutting torch has substituted for the power drill to good advantage on occasions too numerous to mention, where holes were required in steel plate or shapes.

Oxy-acetylene equipment is used for many material and labor saving operations in the mine itself, wherever open flames are permissible. In a gaseous mine no risk should ever be taken under any condition which might involve the possibility of gas or coal dust explosions, or fires. We transport our oxygen and acetylene cylinders inside a wooden powder car with a wooden-covered top, an electrically insulated bottom and an electrically-insulated coupling between motor and car. This eliminates any possible danger of the cylinders coming in contact with electricity or of a sudden ground through car or motor.

Many other precautions are observed in handling oxy-acetylene equipment in the mine. It is, of course, required that the operator should have a thorough knowledge of the necessary safety precautions and the care of welding equipment. In addition to precautions that are ordinarily observed above ground, it is the practice in the mine not to move the car with the regulators connected to the cylinder. When in use, the cylinder valves are opened just enough to permit operation so that they may be quickly closed in case of emergency. All connections are checked for leakage daily and flames are never used about the cylinders.

In the mine, welding and cutting equipment is used in drainage work, track work and for emergency repairs to pumps, locomotives, cars and cutting machines. The welding torch has been found very handy for rebabbitting pump bearings, the bearings being rebabbitted without removing the pump from the mine. The old metal is melted out and the new metal is heated with the torch and poured into place.

In drainage work, the welding and cutting torch is used to repair or to alter existing pipe lines, to take up old lines and lay new ones. The torch is particularly useful when it is necessary to take up and reclaim old pipe where it would otherwise be very hard to unscrew the corroded threads. When altering existing lines or putting in new lines, turns of any angle are made with the torch, either by heating and bending, or by welding an angle turn. On one occasion a simple bend saved the necessity of taking up considerable track and cutting a concrete wall. The work was done on an off-day with no loss of time to the mine and it required but one hour to make the bend and return the welding equipment to the tipple.

At another time, there was a stoppage in a line. We cut small holes in it to locate the stoppage, found and removed the trouble and later welded up the holes. This saved taking up about 200 to 300 ft. of pipe line.

In laying pipe lines in the mines, we have found welding particularly advantageous where it is necessary to put lines in very close places and where there are many corners of varying angles to turn.

When repairing cutting machines, the cutting torch is used for removing rivets and bolts, so that worn and broken parts can be reclaimed by welding or be replaced. Broken lug screws can be cut out without removing the lug or injuring the threads. Stuck and broken bits have been removed in like manner. Cutting chains are assembled by heating the ends and the rivets with a torch and heading them over.

The cutting torch has made economical a very satisfactory method of supporting roofs in roadways where the crumbling nature of strata overhead has made it necessary to provide some means of keeping the track clear. Old railroad rails are cut with the torch to the proper lengths and rested in holes cut in the side walls next to the roof. These rails are placed 4 ft. apart across the haulage way, and posts are laid on top running parallel with the track, forming a rock-proof roof. When the posts are covered with fallen dirt, this seals off the air and prevents further disintegration. This method of timbering has come into wide use in other mines as well.

The transportation system of a coal mine is vital to its successful operation. Speedy and economical maintenance and extension of trackage is possible largely through use of the cutting and welding torch. Repairs to cars and locomotives are made easier by this means also.

In track work, we cut all rails other than standard lengths with the cutting torch; we also cut fishplates and bolt holes when needed. Measurements are taken in the mines, telephoned or sent out, and the rails are cut to conform with these dimensions. Very often, bolt holes do not exist or are improperly placed for the fishplates when connecting rails. It is very convenient to lay the track, putting in all the bolts possible and then cutting any new bolt holes needed with the fishplates in places as these are already tight against the rail. While this may not seem to be such good practice from a mechanical viewpoint, it is a time-saver and results have been satisfactory. It is general practice also to weld the rail bonds.

When taking up old track, the old bolts are cut out and it has also been found that cutting off the old spike heads speeds up the work. New bolts are cheaper to use than old ones with rusted threads.

We have found it quite economical and time-saving to fabricate our own frogs, latches, latch-lugs, bridles, switch throws, guard rails, and crossovers. Cutting, heating for forging, and welding operations are done with oxy-acetylene equipment.

Frogs are made by cutting the rails to proper lengths, then cutting a vee out of the ball and web of the rail so that when the two ends are bent together in the blacksmith shop to make the proper width of frog, the cuts will come together. After this, cuts are made on the outside of the vee to make a straight line from the ends to the point on the ball of the rail. This is again forged smooth and the guard rails are bent to shape. The holes for the rivets are cut and all that is left to be done is the riveting. It is often more economical to heat rivets with the torch where a forge fire would not be practical or where a quick heat is needed. We have found bricks convenient as a bed for heating rivets because they retain the heat.

Guard rails are made by cutting off the web of the rail, leaving enough material ahead of the spikes on the inside when laid. The cut runs out near the ends at an angle to allow the cut to make a straight line when the rail is bent.

The cutting of latches is a simple procedure. The cuts are made with a straightedge and the latches are then forged into proper shape. It would be difficult to tell some of our latches from manufactured ones.

When frogs have become worn, we often repair them by heating them in a forge, cleaning off and welding. It is obvious that this method is economical and speedy. When welds occur on the upper surface of the rail, they can be forged by hammering after the welding is finished and this gives a very tough and smooth wearing surface.

In general, for the remainder of the track work, it is simply a matter of cutting out and welding together whatever is needed. Occasionally broken track joints are welded, but only where fish-

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plates can not be used. Repair work on the rock tramway from one end of the system to the other is performed in the same manner, with similar economies and success.

In the repair of cars and locomotives, the cutting torch in particular is very valuable for quickly removing parts that are to be replaced. Rivets and rusted or worn-out bolts are cut off and broken cap-screws are cut out; broken and worn-out armature pinions are replaced without removing the armature by making a cut over the keyway, thereby eliminating any possible danger of cutting the armature shaft. Few keys are ruined in this way. The same method is also applied to the removal of worn-out or broken gear wheels in many places about the mine.

The cutting torch also eliminates the necessity of a press for taking off the wheels from worn or broken axles. By cutting the axle off close to the wheel, driving out the key and splitting the short piece in the hub, it can be easily driven out. This method has been used in many other places where axles and shafting were to be scrapped and new ones replaced, with no trouble from cracked hubs.

All worn locomotive tires are reworked with the cutting torch. A rim of metal is often left on the outer edge of the wearing face of the tire opposite the flange due to the width of the tire and the narrowness of the rail. To cut off this rim, it was formerly practice to turn off the metal in the lathe, but we have found it has served just as well to cut off the rim with the torch. It is not only much cheaper this way but it is done without removing the wheels from the locomotive which is a great saving in time. The cut is not made parallel with the wearing face but runs in at an angle of 25 to 30 degrees, coming out to the surface of the tire just before the rim is completely removed. This has been a very practical application of cutting.

Besides cutting, welding can be used in the repair of the entire locomotive, as it, like the coal-cutting machine, is almost exclusively made of metal. Frames have been welded where worn out by the journal boxes. It is convenient to weld broken resistance grids together without removing them from the locomotive unless it is necessary to rebuild them anew. Most of the welding on locomotives and cars is done in the shop except when it is very easily done underground or when it is not desired to take them out of service.

A coal mine is no larger than the capacity of its tipple and it is just as important to keep it operating as the transportation system. Our tipple and the machinery in it are made entirely of metal with the exception of the concrete foundation, floors, and a few wooden ties. On the upper of three floors are a two-car Link-Belt rotary dump with its accompanying machinery, a car kick-back, and a double chain haul to take the empty cars up an incline back into the mine. On the second floor are twin screens and picking tables with their machinery and a scale house at the extreme end. In a gallery in the front are air compressors, oil switches, chutes and the chute door machinery. These chutes divide, allowing the coal to go to the picking tables and the rock to a bin. Wing doors operated by compressed air separate the rock in these chutes. On the lower floor are the rock disposal machinery and crushers. The rock is carried out by means of an aerial cableway.

A detailed description of the work done at the tipple with the welding and cutting equipment would take quite long and only a few of the applications can be mentioned here. Broken parts at the dump are repaired by welding as are track and chain haul. Bent and broken car couplings are cut with the torch, thus keeping the roadway clear and the dump working continuously throughout the day. Chutes and wearing plates are repaired or replaced by means of welding and cutting.

Broken parts and castings are sent to the shop for welding if convenient. It has been found advantageous to use steel forgings and structural steel cut to shape with the torch and welded, in place of castings in many places, thus reducing breakdown to a minimum. Welding and cutting operations at the tipple are second in importance only to those done in the shop with respect to the many economies made possible.

A good example of the superiority of repair work with oxy-acetylene equipment occurred at the time of a break in one of the rails which runs the full length of the dump for 24 ft. Forty-two bolts that held the rail in place were cut out, the rail was removed and the new holes were laid out and cut with the torch. The new rail was replaced and the job completed by three men in 2½ hours. It was not necessary to use the cutting torch on any of the holes after the rail was replaced and a better job could not have been expected of a drill press.

In the demolition of structures and for salvaging iron and steel in all forms, the cutting torch is without rival. At the time a new tipple was erected, the old one was torn down by cutting out joints and rivets with the torch. The I-beams, channels, angle irons, plates, etc., which were thus salvaged, were used for a great variety of purposes, such as a frame for the siren on top of the shop, a bridge between two openings in a hollow, a chute for the domestic coal bin, angles for the corners of mine cars, channels and angles for frames of cutting machines, angles for guards, channels for mine car boxings, and for reinforcing weak and broken parts in the new tipple. The heavier plates were cut for frog plates and for various other purposes in the blacksmith shop. The heavier I-beams were cut to proper lengths and were taken inside the mine for roof supports.

At the time an installation for a substation and fan were made, welding and cutting equipment was used extensively. Plates for leveling the machinery were cut to size as were concrete reinforcing rods. Many rivets and bolt holes were cut also. Guards for the machinery were made in the shop, taken to the building and erected. The guards were made to be taken down in the least possible time so that repairmen could get to the machinery quickly and without hindrance in case of a breakdown. They are made of expanded metal bronze-welded to angle irons. A further use for the equipment was in fabricating special clamps to fit over the lower part of I-beams so as to make installation of machinery easy. The oxy-acetylene flame was also used to solder electrical connections.

By far the greatest saving with oxy-acetylene welding and cutting equipment is made in shop work in connection with the machine and blacksmith shops. A large proportion of the track, locomotive and car work previously mentioned is done in the shops, especially when forge or machine work is required. However, less work is done in the shops than formerly, since the transportation and delay in getting work from location to the shops and back again is expensive and unnecessary in many instances. The cutting torch substitutes for saw, drill and even lathe or shaper. The welding torch is used for heating work before forging or bending in addition to welding and often the welds themselves are forged while hot, especially on track work.

The same is true of much work done in the shop. Considerable blacksmith work can be eliminated by using the torch for bending, cutting holes, cutting off pieces, cutting irregular lines and shapes, annealing, tempering, casehardening and welding. Many worn parts are built up to over-size either by welding with steel or cast iron rod as the case may be, or by welding with bronze rod which is very easily applied. They may then be machined off to size. Hard-surfacing materials are also readily applied with the welding torch. Much machine work is eliminated on steel by first cutting to approximate size.

When repairing and wrecking mine cars, bolts and rivets are cut off, iron straightened, broken parts welded, and new holes cut. If difficulties are encountered in the iron work, they can almost always be remedied by the welding or cutting torch. We find this equipment indispensable for car repairing.

Among the routine jobs which come into the shop are pump cylinders and castings of various descriptions to be repaired either by welding with cast iron rod or by bronze-welding. Bronze-welding has been found to be very satisfactory for repairing cast iron since little or no preheating of the work is necessary. Teeth in pump gear wheels are welded when broken and sometimes a broken gear wheel will be welded when a new one can not be procured immediately. Other important parts that are welded are cylinder heads, connecting rods, bearing arms, pistons, and other pump parts. To renew small bronze bearings, the holes are filled full by bronze-welding and are then bored out to size.

In the armature shop, the welding torch is used as a source of heat for removing and replacing shrunk collars, heating commutators and heating soldering irons as well as for applying solder and bronze directly to connections. At one time, a large brush holder ring on one of three generators was broken in service. In repairing the fracture, the ring was expanded with a track jack, the break beveled and welded after which the jack was released as the weld cooled. The casting was a perfect fit when replaced, as the right amount of gap was allowed in the joint for cooling.

These examples of the uses to which oxy-acetylene welding and cutting torches can be put should serve to convince any operator that this equipment is a most important means for making savings in labor and materials, and for increasing operating efficiency in every phase of mining.

Economies Through New Types and New Uses of Materials

By R. E. Hobart*

IT IS the purpose of this paper to confine the discussion of the economies obtained through uses of newer materials to the preparation of anthracite coal, as time and space would not permit as broad a discussion as the committee's title suggests.

This is truly an age of substitution, no doubt prompted largely by the idea of reducing costs. This means more attention in preparation work to places having high maintenance. A study of high maintenance nearly always shows that water of high acid content is a considerable factor in increasing maintenance, due to more rapid destruction of materials. Wash-water analyses show a wide range of acidity for different collieries. At our Alliance colliery the free acid is 25 parts per million, as compared with our Cranberry colliery, where the free acid in the mine water, which is the only source of supply, varies from 300 to 500 parts per million, or a total acidity of free acid plus acid parts of from 800 to 1,000 parts per million. The acid variance at Cranberry colliery is no doubt due to difference of rainfall inflow to mines. Because of conditions at this colliery, the cost of neutralizing the water made it impractical, so that the substitution of material to stand the service was most actively studied here. Except where noted, all data will apply to this colliery.

The biggest single item of expense is the cost of perforated shaker plates, particularly for the smaller sizes of coal. In the same service the average life of a steel perforated plate for use on buckwheat, rice, or barley is 40 hours; of manganese bronze, 250 hours; of 12-16 chrome steel, 400 hours. The relative cost in service, considering the cost of each plate, the expense of $1.20 per plate to change it, including bolts, and not allowing any credit for scrap or salvage value, is shown in the following table:

	12-16 Chrome	Bronze	Steel
Length of service—hours	400	250	40
Average cost per plate	$30.00	$28.00	$5.00
Relative cost in service	.503	.755	1.00

This shows a considerable advantage for chrome plates over bronze and steel from a cost standpoint. There is one big objection to the chrome plate from an operating standpoint, and that is the tendency for gravel to lodge in the small perforations and become permanently fixed. This feature naturally reduces effective screening area; in fact, have seen plates at least 75 percent blind on this account. Severe hammering to remove the gravel often damages the thin plates. To overcome this objection of blinding, it is necessary to restrict the use of these chrome plates to sizing of coal after it has been cleaned, when the gravels have been removed, and not use it on any screening of run-of-mine or stripping product containing a large percentage of this gravel material. Against this serious objection of blinding, which is not as common with either bronze or steel plates, is the advantage which chrome steel has alone over the bronze or steel, and that is the size of the holes does not increase as the plate wears. This feature overcomes the loss in sizing, due to increase in size of the hole. The chrome plate wears to a paper thinness and then fails.

Another advantage of the chrome plates is the ability to use plate thickness of from 2 to 3 gauges lighter than commonly used for bronze and steel. This thinner material, aside from less weight to handle, unquestionably produces greater screening efficiency. At another colliery where the water conditions are good, approximately 30 parts of free acid per million, chrome plates are in service to date 2,200 hours, and will run a long time before wearing out.

Monel metal perforated plates have been used, and are still used by a number of other operations. Tests run several years ago by my company on this material, while giving good wearing qualities, did not prove of sufficient advantage at that time to continue its use.

The substitution of chrome steels for perforated shaker plates has only been of fairly recent development; its introduction was considerably hampered at first by the difficulty in perforating. This difficulty has been greatly reduced, although still a problem.

Chrome steels are also being rapidly substituted successfully for other parts subjected to high acid content along with abrasive material, as sand in the water. For example, jig rubbing plates, jig grates, stationary dewatering screens in front of overflow type jigs, chute plates, piping and lining of pumps. Have even used monel nails where steel nails failed, due to acid water.

In the case of centrifugal pumps, lining and impellers, pumping this bad water and sand mixture at Cranberry, find the following service record for impellers:

	Manganese	Chrome Carbon Steel
Length of actual operation	320 Hours	2,100 Hours
Average cost	$46.00	$102.00
Relative cost in service	1	.384

At another operation where the water is almost pure, the life of the manganese impeller is such that it is not believed necessary to use the more expensive chrome impeller. It is again a case of conditions determining the type of equipment best suited.

Rubber piping, both hard and soft, has within the last year been placed in service against cast iron and wrought iron. Thus far there are no definite figures, but it is believed the rubber will show a saving. In the case of soft rubber, it has a further advantage of being more easily handled and needs no elbows, and can easily be disconnected and attached in case of pump repairs. Hard rubber, with its fittings, should only be used on water that contains no grit. The soft rubber has found considerable favor in use at plants handling sand and water together.

Rubber covers and rubber strips give better service on concentrating tables than linoleum and wood strips. However, in the case of anthrafine, the advantage is in favor of the linoleum, probably due to the minimum erosion account of smallness of material.

The substitution of wood tanks wherever possible for metal tanks in the cleaning process of the sand flotation system has shown considerable advantage in favor of the wood. The main agitating cone, while made of steel, does not wear out as quickly as may be expected, due to the protective layer of sand formed on its inner surface, account of the centrifugal action of the mixture in the cone. Am advised that one company lined an agitating cone with soft rubber as a protective coating. Several times the lining has been torn, so that its effectiveness is questionable.

Have found in our foundry that the addition of 2 percent F. nickel shot and 1 percent ferro chrome to our ordinary cast iron has increased its wear resistance over straight cast iron as chute plates approximately 4 to 1.

Experimenting with the use of aluminum, have found it resists the wash water corrosion five times as well as steel. However, results on erosion are not as good. This means it can only be used on places to resist the acid condition, with absence of grit.

I have only given the more important features of the study of reducing maintenance by substitution of other materials, but it is believed in this day of research and special materials that still further reduction can be made in the maintenance costs by the development and use of more effective wear-resisting materials.

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Conveyor Mining

I. N. Bayless

Chairman

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Union Pacific Coal Co.

Safety

Thos. Moses

Chairman

Pres.

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Room and Pillar Mining with Conveyors

By R. H. Morris*

IN THE SPRING of 1928 our engineering department investigated several mines using various types of conveyors for loading coal, especially as to the adaptability to use in our mines.

The result of this investigation was that we decided upon the drag-chain type of conveyor as most suitable for our conditions, and on June 16, 1928, placed an order with the Kanawha Manufacturing Company, of Charleston, W. Va., for one unit. The general specifications were worked out between our engineers and the engineers of the Kanawha Manufacturing Company, and in general are as follows:

1 drive head unit
1 tail end unit
43 pan sections
2 12-ft. face conveyors

Drive Head.—The drive head unit is equipped with a 15-hp., 550-volt, compound-wound, 1,050-r. p. m. motor.

The reducing gear is type AH-300, Cleveland worm gear reduction, and Falk flexible coupling for motor connection. Motor and reducer are mounted on a detachable base with adjusting screw for chain tension.

The boom is 6 ft. long and is a part of the main conveyor elevated to suit conditions.

The trough is made of 3/16-in. steel, 16½ in. wide on bottom and flanged out to 22 in. on top and depth of 6 in.

Tail End Unit.—This is made up of structural steel frame with take-up boxes.

Pan Sections.—These sections are 6 ft. 0 in. long, each consisting of a formed pan 16½ in. x 22 in. x 6 in.

The conveyor chain consists of a double strand of No. 188 Hercules steel and malleable iron, having a tensile strength of 14,000 lbs. each.

Cross bars are ½ in. x 1 in. steel electrically welded to the chain on 16-in. centers.

Face Conveyors.—These conveyors are 12-ft. centers, and the same dimensions as the pans of the main conveyor unit.

The drive is a 1-hp. motor with Cleveland worm gear reducing unit.

The face conveyors have handles on back end and mounted on ball-bearing casters on drive end for ease of moving.

Capacity of conveyors, 60 tons per hour.

Additional equipment for complete unit consists of:

1 Sirocco blower with 3-hp. motor.
Flexible tubing for blower, 275 ft. of 8-in.
1 Sullivan portable hoist, 6½-hp. motor, and 300 ft. ⅜-in. rope.
1 Little Giant coal drill with auger bits.
Copper wire and double cable.

The total delivered cost of the complete unit as above noted, $4,820.91.

* General Manager, The Gauley Mountain Coal Company, Ansted, W. Va.

It was decided to try out the conveyor at a location fairly remote from any hand loading operations, and the Old One East mine was selected, where an area 550 ft. by 600 ft., about 7½ acres containing 40,000 tons of coal, is available. The coal being 40 to 42 in. in thickness, carries an irregular parting up to 6 in. and has moderately bad roof. In general, the mining conditions were not so favorable as the average of the other hand-loading operations.

No entries for the extraction of the 7½-acre block existed, and the first work of the conveyor unit was to drive a heading and parallel air course 550 ft., which developed half the 7½-acre block. In the entry, bottom was taken for height track width.

The unit was put into operation September, 1928, and by January 8, 1929, the heading and air course were completed. The heading and air course were driven 26 ft. to 28 ft. in width, as this proved the most convenient for operating the mining machine and face conveyor, as well as giving extra room for gobbing.

The heading and air course having been completed, No. 1 room was started, width 35 ft. and 25-ft. pillar, or 60-ft. centers, as illustrated by sketch attached.

Two face conveyors working in tandem were used in the rooms.

The crew for this unit working in rooms consisted of three men at the face and one man at the loading point. A shortwall mining machine was kept at the face for cutting and was operated by one of the crew. The results obtained by this conveyor were such that we decided to install the second unit; consequently an order was placed with the Kanawha Manufacturing Company for a duplicate unit on December 27, 1928, except that 24 pan sections were ordered and 3 face conveyors. This, together with the additional equipment for the complete unit, cost $4,961.80.

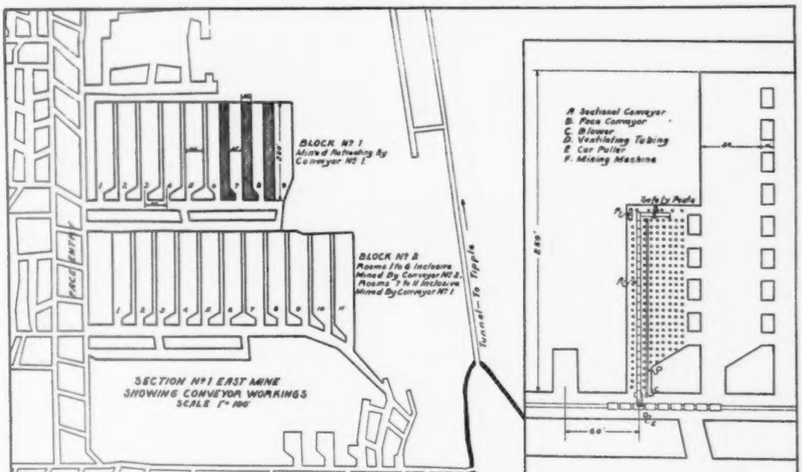
This second unit was placed in operation in May, 1929, and was used in driving 800 ft. of entry and air course, which was completed by November 1, 1929. On this date No. 1 conveyor had completed the block of coal first developed, having loaded 18,672 tons of coal. In driving the entry and air course, No. 2 conveyor loaded 4,175 tons of coal. The total coal loaded to this date, November 1, 1929, amounted to 22,848 tons by both conveyors, which includes entry development.

The labor cost, compared to hand loading over the same period of 315,859 tons, was 88 percent of hand loading.

For the year 1929 the two conveyors loaded 25,206 tons, and more nearly represents normal operation, as compared to 271,512 tons over the same period by hand loading. The labor cost by conveyor over this period was 86 percent of that by hand loading. In making this comparison of labor costs, it is the total labor cost of coal on board railroad cars, as both conveyor and hand loading take their pro rata cost of the general labor expense.

The haulage equipment used was the same in both cases; that is, it is not especially adapted to coal as low as we must mine, and the track gauge being 30 in. was also of a disadvantage.

In hand loading a large item of expense is due to yardage, on account of getting height for haulage equipment. This expense is greatly eliminated by conveyor loading, due to no yardage being taken in rooms, as only yardage is taken in the entry for height.



In another part of the mine where we were able to later use low equipment on a 44-in. gauge, under very similar conditions, we have shown with low equipment that the labor cost can be done for 78 percent of that on the narrow gauge and higher equipment.

From our experience, it would seem that where the coal is of such height that the equipment available can not be used in rooms and pillars without taking yardage to get height, then conveyors no doubt can be operated more economically than hand loading, and it will be the means of operating seams of coal that otherwise might not now be worked.

The attached sketch shows the area of the mine worked by the conveyors and the method of working. It will be noted that the first rooms driven in block No. 1 were driven up to the limit, 250 ft., and pillar drawn on retreating. This method was tried out but was abandoned for the reason it was necessary to carry the main conveyor unit on the rib next to the pillar, which made it difficult to protect; also in drawing the pillar there was difficulty in maneuvering the mining machine, together with extra hazard. These first rooms being on 60-ft. centers, and 35 ft. in width, left a 25-ft. pillar.

In attempting to draw these pillars, it not only proved expensive, due to slowing down production, but hazardous; consequently, the rooms were widened up to 50 ft. with a 10-ft. pillar, and the main conveyor carried on the solid coal rib. This 10-ft. pillar was honeycombed on advancing, leaving only small stumps for support. This method proved very satisfactory, as well as giving a large percentage of extraction. The room stumps on the entry were taken out by hand pick work and loaded on cars from the track serving the conveyor.

During the period we were operating the conveyors we found quite a number of changes and improvements in the conveyors themselves, also in the method of operation.

One of the improvements made in No. 2 conveyor was that of equipping throughout with antifriction bearings.

The fact that one shortwall mining machine is part of the unit reduces the tons cut per shift per mining machine to the capacity of the conveyor, as it is not practical to move the mining machine from the face served by the conveyor unit.

There is no doubt an advantage in conveyor mining from the standpoint of concentration of working places, thereby getting a large tonnage from a restricted area.

In the matter of investment, if we take the cost of the two units as above noted and the cost of two mining machines, we have a total investment per unit as follows:

No. 1 unit	$4,820.91
No. 2 unit	4,961.80
Two mining machines	7,750.00
	$17,532.71

The tonnage produced in 1929 by the two units as above given was 25,206 tons; however, this tonnage is for No. 1 conveyor for the entire year, while No. 2 conveyor started in May of that year. If the two conveyors had worked the entire year, the year's tonnage probably would have been 33,324 tons, or an average of 2,777 tons per month.

In order to arrive at the investment per ton of yearly output, we would have the following: $17,532.71 divided by 33,324 tons equals 52 cents per ton investment on yearly output. This is probably higher than what might be expected if a greater number of conveyors were installed and efficiency increased.

While the investment per ton of yearly output on mining machines is high, due to using one on each unit, the investment on mine cars, locomotives, and track no doubt would be less, due to more concentrated system of mining. The system of mining is of great importance in conveyor mining, especially as to haulage. The capacity of the conveyor is such that when coal is coming the cars must be at hand to take care of it.

The planning of the working places must be such that there will be a minimum danger from local squeezes or bad falls of roof, as the complete unit is not very readily portable and can not be suddenly taken from the danger zone.

From our experience, we believe there is a place in mining rooms and pillars for conveyors such as we have used, and under certain conditions may prove economical.

Each mine presents its own peculiar problems, and before making any radical changes in the method of mining the advantages and disadvantages of mining by conveyors should be carefully considered.

ECONOMIES TO BE REALIZED THROUGH PROPER POWER DISTRIBUTION

(*Continued from page* 31)

A track joint with more resistance than 6 to 8 ft. of solid rail is poor economy.

A 45-pound rail joint properly bonded with a 4/0 bond will have about 5 ft. of solid rail resistance. Since you have a track area in circular mills with a resistance equal to the positive feeder, you will be able to get the same work done several hundred feet farther away from the generator without additional feeder or generator equipment by lowering the resistance of each track joint. An economical measure well worth the investigation, and can be easily and quickly checked with a Duplex Milli-Volt Meter, or other means.

The kilowatt-hour is the unit by which power is generated, bought, used, and paid for. Of course, the totalizer and check meters are prevalent, but do not give us a true picture of our power consumption. Distributing meters are the "watchdogs" for power consumption, and have a moral effect upon the users of power which reaches beyond that particular phase of economy.

ANTHRACITE PROBLEMS

(*Continued from page* 22)

omy, safety, which are things worth paying for.

In cooperation with Pennsylvania State College the Anthracite Institute is conducting extensive research toward increasing the uses for anthracite for other purposes than fuel, and some definite progress has already been made. It has already been demonstrated that as a filtering material for urban water supplies, it is decidedly superior to sand, and that it makes an excellent substitute for cocoanut shells as a filter in gas masks. Other developments are in the making.

The Anthracite Institute Laboratory at Primos, a few miles out of Philadelphia, is doing a much needed work in the testing of various types of anthracite burning equipment, and in the development of equipment looking to the further extension of automatic and economical anthracite combustion. An important device now on the ways and which will probably be ready for launching at an early date is a furnace of entirely new design, adaptable to either steam water, or warm air heating. It will use any size of anthracite from egg to chestnut, or even smaller sizes, or mixtures of them as automatically and as mechanically and thermostatically controlled as are the magazine or stoker furnaces for the use of buckwheat or rice.

In fact, the anthracite industry is not only alive to the problems that confront it; it is awake and as it has solved those of the past, so will it meet and solve those of the present and the future.

THE REAL COAL PROBLEM

(*Continued from page* 28)

Now, gentlemen, I feel very earnestly and very strongly that we have a very definite job to do in the bituminous coal industry. We have got to adjust our business to meet the competition of these substitutes. We have got to increase our efficiency of our production. We have got to improve our methods of distribution, and we will be able to hold just so much of the fueling business of this country or of the world as we are entitled to by the efficiency which we reach. I use that word "efficiency" to cover not only the actual practical efficiency, but the cost price at which we can give the coal to the consumer, whether that consumer is a householder or an industry, and those who make a profit in the industry will be those who can supply the coal at a margin of cost to them below that competitive price.

The chaotic condition which succeeded the war and skyrocketed the price of coal, which was a condition brought about by these strikes which I have spoken of, is something for which we are paying today. This is a world of action and reaction. I have no doubt that the high prices received in those days and the profits which resulted from them have all melted away, so that we are about back to where we started, and if it hadn't been for them, if it hadn't been for those absurd prices, the urge for fuel economy would not have

(*Continued on page* 92)

The Portable Hoist as a Haulage Auxiliary

By A. E. Roberts*

AS A DOORBOY in a Pennsylvania anthracite mine I first came in contact with mine haulage problems. Recalling those days, I remember the first problem that intrigued me—who was employed at the seemingly endless task of naming the mules. Animal power in those days certainly constituted the backbone of haulage, though it is true that even then we had the endless rope, slope haulage, and the gravity plane as accessories.

There was even at that time a trend to mechanization, though certainly a very slow one. Many of the early mechanized units were designed to fit into the scheme of things as was, with comparatively little gain economically. During the intervening years, varying types of haulage units were subject to investigation and experimentation. We have had contemporaneous development of the air locomotive with its tremendously high pressures, the gasoline locomotive with its noxious fumes, and the electric locomotive—both trolley and battery.

During the last decade the lash of necessity, the new economic theory of mass production—tending to centralize and intensify effort in the will to survive—have borne fruit in mining as well as in other basic industries, as is evidenced by the many splendid examples of the mechanical and electrical arts now adjuncts of mining. Nor can we be unmindful of the great part the American Mining Congress has played in this progress through the interchange of ideas and the demonstration of new devices.

Haulage may be roughly divided into two divisions without, however, assuming any strict line of demarcation. First, main haulage; second, gathering haulage. We have in a comparatively short compass of time viewed the expansion of main-line haulage from the matter of hauling small trips a comparatively short distance, to long trains of huge cars hauled many miles per trip. On the other hand, while the picture has definitely changed, the gathering stage has not been as widely benefited.

This is in a great measure due to the imitations imposed. These imitations, though not all inclusive, may be briefly cited as follows: First, natural seam condition; second, method of mining; third, artificial conditions.

Natural Seam Condition.—Many coal seams are low, precluding without excessive cost the use of many excellently designed units for gathering purposes; nor will roof conditions in many cases permit concentrative systems of mining.

Method of Mining.—To a large extent, the prevailing method of mining is the room-and-pillar system. Such a system, with its modifications, necessitates visits to many points to gather cars. While mechanization at the face has tended to change this condition, there remain many operations where this system and hand loading are still in vogue.

Artificially Set Up Conditions, such as a shaft, may impose severe limitations on the design of cars.

These limitations may belong in the category of things eliminative, but not economically so under present conditions.

Despite many natural and artificial handicaps, many operations have managed to survive though committed to the room-and-pillar system and hand loading. This has been made possible through the employment of a haulage auxiliary that as yet, so far as I am aware, has made no universal appeal to the mining industry. This unit, known in the central bituminous field of Pennsylvania as a room hoist, has made it possible for low-seam operators to plan a haulage system that functions smoothly, economically, and satisfactorily.

My experience with this device has been localized but covers many years of contact, and what is said of types most familiar to me may by implication be inferred of other types for the same service. The first room hoist that I have heard of was designed for the Berwind-White Coal Mining Company by the Pneumelectric Machine Company about 1912. About the same time the Lidgerwood Manufacturing Company built a hoist of this type. These first hoists were small and capable of light duty only. There were limited applications of these hoists until about 1915, when more operators began to use them. In the period of 1916 to 1920, the Cherry Tree Machine Company, the Flood City Manufacturing Company, the South Fork Foundry and Machine Company, local Pennsylvania manufacturing concerns, also brought out room hoists improved and of greater capacity.

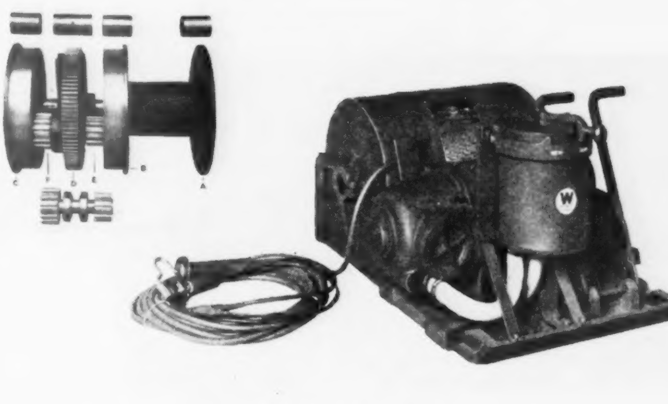
Essentially the room hoist consists of a cast-iron base, approximately 2 ft. wide by 4 ft. long, on which are mounted a 5-hp. motor with its starting device, a train of gears interrupted by a clutch arrangement, and a drum with winding space for up to 600 ft. of ½-in. rope. In the early types the motor was usually provided with a starting resistor, and the clutch was either of the jaw or planetary gear type. The jaw clutch was mounted on an intermediate shaft and engaged the drum driving pinion. The planetary gear type of clutch consists of an intermediate gear mounted on the drum shaft and carrying in its web a shaft having at either end pinions of different sizes. Each of these pinions engage internal gears; one mounted on the rope drum, the other being part of the clutch drum. Retardation of the clutch drum by a brake band acting on it causes motion of the rope drum, due to the differential action of the pinions.

The early types of room hoists recorded many failures: Bases, frames, and gears gave way; motors and starting devices burned up; flanging ropes fouled the gears; greasing systems failed to function, and operatives sometimes completed the destruction. The planetary type, though failing in its early design from inherent weakness, demonstrated clearly that the design of a room hoist should incorporate the feature whereby the load can be gradually accelerated mechanically, avoiding the use of control resistors, a veritable nuisance in the early types.

The important requirement is, I believe, the ability to completely control the speed of the rope, since hauling is usually done on light track poorly aligned, loosely put together, and abounding in short curves. Based upon considerable experience, I believe the room hoist should have incorporated in its design the following features:

A substantial base and frame to resist the strains of set-up and rough usage.

Rugged gears housed in substantial enclosures.



The "Brownie" Hoist
Small view shows detail of clutch and gear mechanism

* Chief engineer, Monroe Coal Mining Co.

View of head sheave

Drum housed to prevent flanging of the rope.

Type of clutch that will permit of easy engagement or disengagement of the drum while the motor is running.

Good sturdy type of motor, heavily compounded, capable of taking full shocks of mine voltage under no load conditions.

Good responsive type of brake.

Simple system of lubrication.

Arrangement of the switch and levers so that the operation of the hoist is completely controlled from the rear, and that when the operative leaves this position of safety the clutch is released.

The most familiar example I can cite of the extensive use of room hoists in mines is the one with which I am in daily contact. At this mine the room-and-pillar system is followed, with the entire production loaded by hand. All loaders in rooms and entries are supplied with hoists. In rooms the hoists are set in the room necks just inbye the entry; in active entries usually on the clearance side. Hoists are first mounted on 4-in. by 6-in. by 6-ft. skids, the skids extending beyond the base to permit posts to be set at the ends with a wooden platform for the operative. The posts used are substantial, set to tighten under strain, and with a view of preventing displacement of the hoist from position under normal operations or unexpected contingencies.

The electrical set-up is as follows:

A solid return is established in at least one rail throughout the length of the entry.

Connections are made in a substantial manner from the positive wire to a fused switch of the quick-acting type, and from the return circuit to the negative motor connection. The positive wire coming in overhead is protected on the entry by a grooved board nailed to pegs in the roof.

The frame of the hoist is grounded to the return circuit by a special wire carefully protected against injury.

Grounding of the motor negative to the motor frame is not permitted, since such a connection will cause the rope to act as a part of the return circuit.

The positive wire is spliced in such a manner that displacement of the hoist will interrupt the circuit.

The rope used at present is 7/16 in. diameter, 6 by 19 preformed. This type of rope has given satisfactory service, but much of the success in the use of this type of auxiliary haulage is in the employment of a sufficient number and proper type of sheaves.

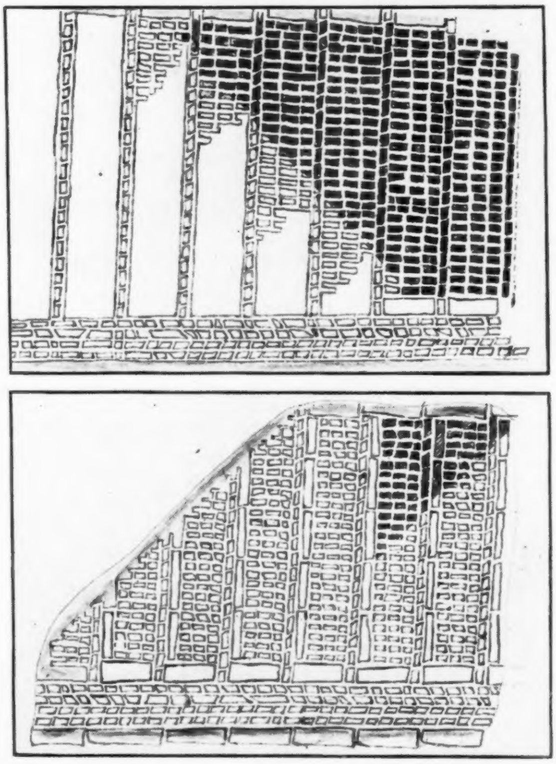
The general layout of the mine consists of a main entry from which are turned main panel entries, and from the latter are turned the panel or room entries. All openings are driven on 60-ft. centers. Two men are usually assigned to each working room and two men usually to each entry and its air course. Each room has its individual hoist and one hoist is assigned to the entry and air course. These hoists are all operated by the loaders.

Main-line locomotives, weighing 13 tons, haul to and from the different sections of the mine. Locomotives of the same weight visit the producing headings to gather their trips, which vary in the number of cars from heading to heading, usually 30 to 45. In placing empties each working place is assigned a certain number of cars, all spotted at appropriate points. Empty and loaded cars are handled from and to these points by the loaders, who couple the loaded cars in groups. The returning motor crew completes the coupling of the trip and are off, returning shortly to renew the cycle.

View of deflecting sheave

year these hoists and 11 locomotives gathered and hauled over 800,000 net tons of coal in 254 working days.

The grades in this mine vary from 2 to 17 percent, and no difficulty has been experienced with this type of gathering haulage, though all kinds of varying



These sketches show the former system and the new system of driving rooms and pillars

The average production per loader last year was 9.8 net tons per day. The tonnage per employe per day, including all classes of employes, was 5.79 net tons. Each hoist handles an average of approximately 13 cars per day, or 4,300 tons of coal per year. There are approximately 190 hoists in this mine. Last

grade conditions have been encountered, sometimes in the same room or entry, maximum grades against and with the load, without interfering with the plans as projected. Haulage up the maximum grades, around sharp curves, with the use of proper type of sheaving, becomes

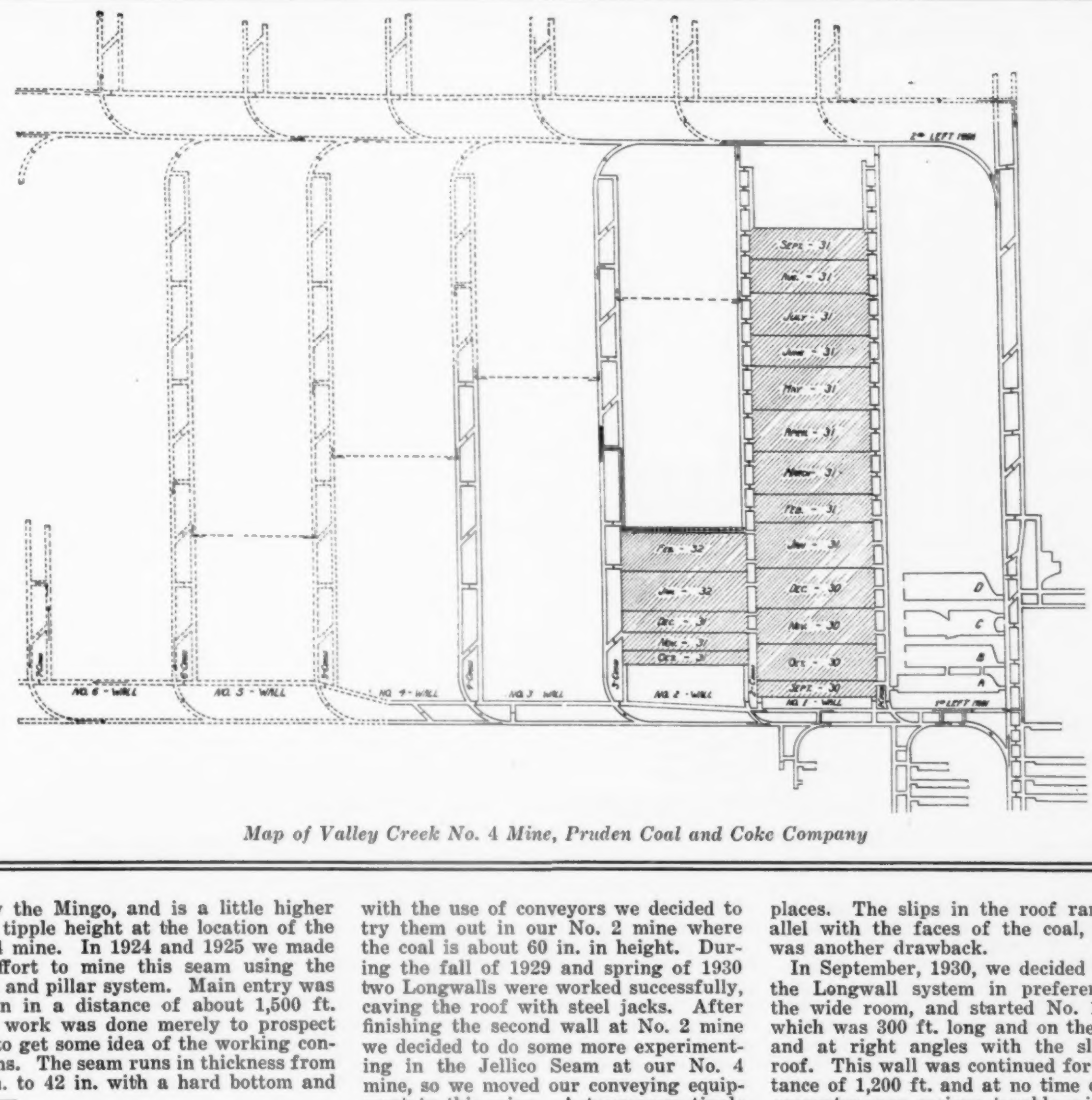
(*Continued on page* 47)

Mining Longwall Panels with Top Cutters and Conveyors

By Charles A. Griffith*

THE Pruden Coal & Coke Company has operated mines in Claiborne County, Tennessee, and Bell County, Kentucky, for the past 25 years in the Mingo or Mason Seam. The Jellico Seam underlies all the property of the company. The quality of this seam is widely known and usually brings a premium price. Realizing the quality of the Jellico coal and the acreage controlled, we thought we should make an effort to mine this seam which lies about 450 ft. below the Mingo, and is a little higher than tipple height at the location of the No. 4 mine. In 1924 and 1925 we made an effort to mine this seam using the room and pillar system. Main entry was driven in a distance of about 1,500 ft. This work was done merely to prospect and to get some idea of the working conditions. The seam runs in thickness from 30 in. to 42 in. with a hard bottom and a rider about 8 in. thick running from 18 to 72 in. above.

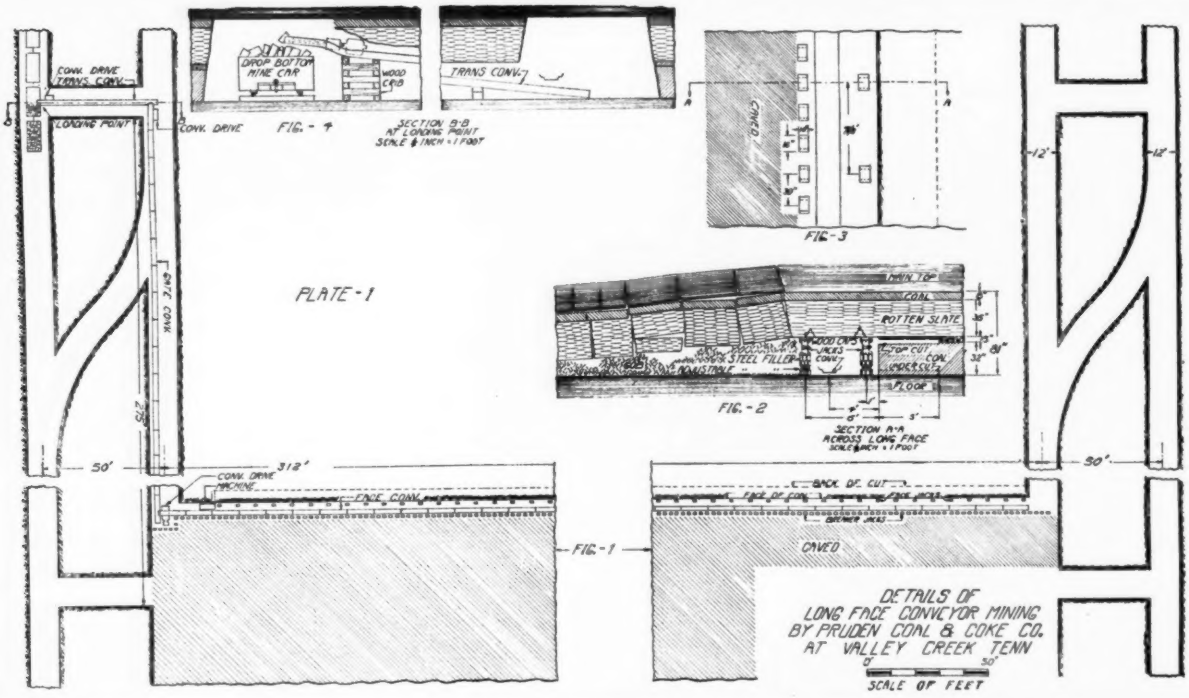
The material between the two seams is of such tender nature it was almost impossible to support it over the roadways in rooms, and for this reason the mine was abandoned in 1925. Early in 1929 we began to think perhaps we could work this mine by using conveyors and by so doing avoid supporting the roof over roadway. Not being acquainted with the use of conveyors we decided to try them out in our No. 2 mine where the coal is about 60 in. in height. During the fall of 1929 and spring of 1930 two Longwalls were worked successfully, caving the roof with steel jacks. After finishing the second wall at No. 2 mine we decided to do some more experimenting in the Jellico Seam at our No. 4 mine, so we moved our conveying equipment to this mine. A temporary tipple was erected. The coal is brought from the mines in drop bottom cars which automatically unload into a chute. From this chute it is carried by a shaking conveyor on a 13-degree pitch to the railroad cars. Screens, making three sizes of coal, were installed on the end of the shaking conveyor. An attempt was made to use conveyors in this mine by working four wide rooms, A, B, C, and D, as shown on map, but on account of having to timber so close to the face we found it required too much time to cut the places. The slips in the roof ran parallel with the faces of the coal, which was another drawback.



Map of Valley Creek No. 4 Mine, Pruden Coal and Coke Company

In September, 1930, we decided to try the Longwall system in preference to the wide room, and started No. 1 wall which was 300 ft. long and on the butts and at right angles with the slips in roof. This wall was continued for a distance of 1,200 ft. and at no time did we encounter any serious trouble with the roof. The entry and air courses were

* Vice President and General Manager, Pruden Coal & Coke Co.



driven on 35-ft. centers leaving a 23-ft. chain pillar, which proved to be too little. We were handicapped very much on account of side rolls from the tender material between the main seam and rider, causing delays in haulage. In October, 1931, wall No. 1 was abandoned and wall No. 2 started. In this wall the entry and air courses were driven on 50-ft. centers instead of 35. We also at this time changed our general layout of the mines. At first we thought that we would drive walls a distance of about 4,000 ft. but according to our new plan walls will be driven 1,200 ft., the coal being hauled through virgin territory, thus eliminating coming in contact with side rolls due from any weight of worked out area.

Projection on this map shown by the dotted lines shows walls No. 2, 3, 4, and 5 working, and No. 6 ready to start. So with this system five walls or more can be worked at a time with all coal going out through second left main entry with the exception of wall No. 6, which will go out first left main.

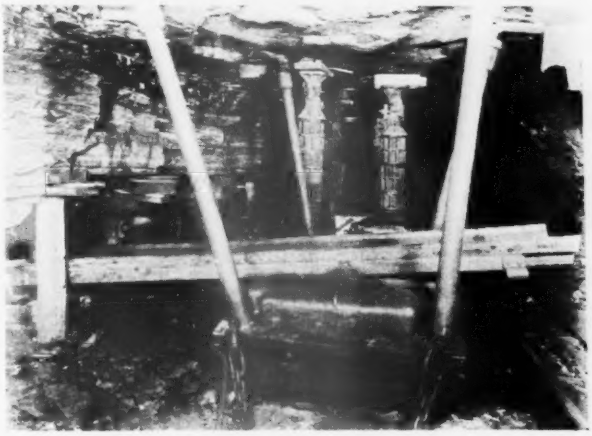
Figure 1 shows a close up of the wall. Face conveyor is a shaking conveyor driven by a C-20 Drive. This equipment is manufactured by the Goodman Manufacturing Company of Chicago. We have encountered some severe dips and rolls, some as steep as 21 percent, but by rippling some of the troughs on the steep incline we were able to shake the coal up without serious difficulty. The gate conveyor can be either shaking or chain drag. Transfer conveyor is a drag account of having to elevate the coal some 7 ft. in a distance of 50 ft. Figure 4 shows a section of the Jeffrey 49-E conveyor carrying coal through break through to loading station on entry where seven to eight-ton drop bottom cars are loaded in trips on a straight track. Cars at present are spotted at loading station by a locomotive with trolley pole on a section of dead trolley wire. Locomotive controller is set on three points with brakes slightly tightened. When cars are to be moved this section of trolley is energized by the car trimmer using a piece of insulated wire attached to dead trolley and bringing it in contact with live trolley wire.

Figure 2 shows a section across Longwall face. Jacks are furnished by the Lorain Steel Company of Johnstown, Pa. These jacks are made up as follows—14-in. collapsible section is used so jacks can be discharged. The required heights are built up by the use of 6 and 12 in. fillers. We have done quite a bit of experimenting with adjustable fillers and believe we have found a satisfactory one. By the use of the adjustable filler a uniform capboard in thickness can be used which saves quite a bit of time in not having to hunt for various thicknesses of capboard. The best capboard is 10 in. by 16 in. and from 2 in. to 3 in. thick. By setting face row of jacks behind cutting machine as face is cut we have been able to move breaker row some 24 in. closer to face than when face row was set so as to pass machine between them and coal face. This change reduced weight on breaker row an amount that was very noticeable.

Face jacks are placed 7½ ft. on centers while breaker jacks are 2½ ft. on centers. The face row of jacks today will be in the breaker row tomorrow. Top cutting is done when conditions will permit. The Jellico Seam is noted for rolls and sometimes we have places that will not permit the top cutter to pass. This machine was specially designed for this work by the Sullivan Machinery Company. The cutting element raises and lowers, and turns right and left while machine is cutting.

Eight or nine loaders load out the coal on the wall in a shift. They are paid by the face foot. Loaders are assigned dif-

Top cutter with cutting bar swung out in position for setting bit



C-20 drive at discharge end of 300-ft. face conveyor showing collapsible jacks at the rear of drive

ferent footage according to their ability. When top cutting is done a shot is fired by each loader so as to work to the back of cut and then 9-ft. holes are drilled parallel with the face at the back of the cut. This method of placing shot has proved much better than holes drilled straight in. When bottom cutting is done very little or no shooting is required. All impurities and draw rock are gobbed. Sometimes the roof breaks off close to breaker row of jacks. When this condition occurs impurities have to be loaded in conveyor and hauled to slate dump.

Wall ready for cutter. Jack pullers can be seen in rear of conveyors

The night crew which does the cutting and moving of conveyors and jacks is paid by the job, the men leaving the mine as soon as the work is finished. This crew consists of eight men and a foreman.

Entry driving is done by seven men divided into preparation and loading crews. Preparation crew consists of three men with a Goodman mounted machine and an electric drill. Track is laid to face. Two holes are drilled in coal at bottom, one at each rib. Two holes are drilled in rider seam at top. All holes are then loaded. Cutting is done at top of coal in cannel draw. Cut is cleaned out and place is then ready for loading crew, which consists of four men with a Myers-Whaley Automat Shovel and a locomotive. First, the cuttings are loaded, then the shovel is backed away from the face a short distance and coal shot up and loaded out from under the top slate. Shovel is again backed from face farther than before, and slate shot down and loaded out. The haulage crew has enough cars to load out the place. The cars are then hauled to tipple and dumped while the shovel is being moved to the next place. The entry crew cut and clean up six to seven places per shift. Ventilation is furnished by blower fans and no time is lost on account of smoke from shots.

After working this system for about two years we believe it is the most economical and efficient way to work this seam—so far developed.

THE PORTABLE HOIST AS A HAULAGE AUXILIARY

(*Continued from page* 44)

commonplace. However, most of the openings are driven to the raise.

This type of gathering haulage permits of a proper continuity in the sequence of mining events that possibly could not be achieved satisfactorily with any other type of equipment. It has been found possible to follow up pillar extraction closer to first mining. This is accomplished by driving the rooms upgrade and taking out pillars in the reverse direction, the pillar coal being hauled to the heading above.

Recently it has been demonstrated that in areas already blocked out rooms could be driven to the dip with top-cutting machines, and the pillars taken out in the logical sequence with considerable saving in the matter of set-up of hoists and a saving of 75 percent in cost of rope.

Repair costs, carefully compiled over a period of years, show that this type of equipment has not cost excessively. Most of the costs are attributed to electrical repairs and the older type of hoists. These costs since 1925 have been as follows: 1926, $15; 1927, $15.65; 1928, $21.60; 1929, $15; 1930, $12; and 1931, $18. In 1931 a considerable replacement of controllers was made, accounting for the higher average of $18. Thus far this year less than $200 has been expended for room hoist repairs.

This type of haulage places a large number of employes in contact with the haulage system and the normal expectation is that such a condition would unfavorably affect the accident rate. This was found to be true, and several years ago a safety committee, organized to investigate all accidents, found that a considerable number of haulage accidents could be classed as type accidents. These were carefully studied and remedies proposed. A campaign of education was launched and continued. Today relative freedom from haulage accidents prevails. Operatives are given careful instructions and contingent dangers are pointed out to new employes. Competent officials make daily inspections, checking the set-up and operation of the hoists. Limitations as to the number of cars hauled are imposed and all installations and operations are covered by general and specific instructions. Disciplinary measures are strictly enforced.

While room hoists have been used primarily for gathering purposes, there have been many other special applications which have in some cases resulted in demands for a larger type. Such a type, capable of 2,000 lbs. normal rope pull at 200 ft. per minute, and equipped with a 10-hp. motor, is now being manufactured.

With the adoption of mechanical mining the tendency has been to use as much available equipment as possible. In many cases room hoists were used to spot the individual cars of the coupled trip at the loading point. Loaded beyond its capacity, in many cases the room hoist failed and thus new and insistent demands were made upon its sponsors for relief. A redesign, retaining the essential features of the room hoist, is now available for the severe service of mechanized loading. Hoists capable of 6,000 to 12,000 lbs. normal rope pull are now available with or without remote control and automatic braking.

Permissible types of hoists have also been developed for use in locations unsuitable for the open type.

The room hoist and its variations has rightly earned a place in the scheme of things. To the loader who formerly pushed his car, a most exhausting type of effort, it has indeed proven a boon. To many low-coal operators it has become indispensable.

Strip Coal Mining in the Southwest

By L. Russell Kelce*

THE states of Kansas, Missouri, Oklahoma and Arkansas are considered the Southwestern coal field, and as most of the strip mining is carried on in the states of Kansas and Missouri, I will confine this paper to these two states.

The strip mining industry has developed very rapidly in the past 10 years in these states where the topography of the country, the uniformly level seams and character of overburden is very favorable to this system of coal mining. These characteristics have been proven to be necessary to successfully operate a strip mine in our section, due to the thin seams that exist there and the low realization that we receive for our product. This can more readily be seen when you realize that the coal seams that are being worked run from 18 to 36 in. in thickness.

The thickness of coal is not always a yardstick or rule to use in determining costs in any field, but its relation to the amount of yards of overburden that overlies the seam of coal. Each stripping field usually determines the number of yards of overburden that they can economically remove for each ton of recoverable coal and this is decided by the market conditions, the character of the overburden and the kind of excavating equipment that they intend to use. In the case of our district, we use approximately 11 yds. for each recoverable ton of coal which figures for rough use 1 ft. of overburden for each 1 in. of coal thickness. This rule has been pretty much adhered to, as the average of this field is approximately 11½ yds.

The character of overburden in this field is fairly uniform and consists of soil, clay, medium hard shale and black slate which usually lies directly on top of the coal seam. However, some mines encounter small stratas of sandstone and limestone, but very little.

The rapid development of this field has been possible only by the economies and efficiencies that have been effected by the operators, which has been brought about by continual improvement in excavating machinery, loading facilities, transportation systems and by improved preparation and cleaning plants.

I will not attempt to give you a detailed outline of these improvements because it would consume too much time, but will try and give you a brief outline of it all.

Strip mining has been carried on in this section for many years before the World War, at first with the team and scraper method, uncovering outcrops, then with small railroad type, semi-revolving shovels and on up until today when you can see large excavating shovels operating in this field weighing in excess of two million pounds, carrying from 12 to 16 cu. yd. dippers, each unit capable of moving a half million yards a month.

The giant machines not only uncover more coal per month or year, but move the overlying stratas at a very reduced price per yard, which reverts in a cheaper cost per ton of coal loaded, and this can be determined by multiplying the savings per yard of overburden moved by the number of yards that is necessary to move to uncover a ton of coal.

These modern excavating machines also make it possible to uncover coal which lies at a greater depth and increases the amount of coal that can be recovered from each piece of land, which means a lower depletion charge per ton. This increased available tonnage makes it possible for the operators to spend more money on his loading and transportation facilities and to install a better preparation and cleaning plant. All of those things lend to cheaper production.

The loading facilities have progressed along with the excavation shovels, coming up from hand loading to power shovels of special design adapted to our field. The loading shovels in this section are all very similar but different from any other field in the mining industry. This machine is a small full revolving shovel, similar to other strip loading shovels of other fields, only that this machine has a movable boom, hinged at the base and carries a flat bucket and is thrust horizontally into the coal seam and resembles a skimmer. These machines have a dipper capacity of from 1 to 3½ tons of coal and are capable of loading from 800 to 3,000 tons per day, depending upon the size of machine and the thickness of the coal seam.

This type of machine is very advantageous to our section of the country, due to the wide working range, and their ability to load out a strip of coal from 60 to 70 ft. in width which is the average width of cut taken by the excavating shovel. This reverts in cheaper track cost as we can load out the full width of the pit with the laying of one track, whereas a regular designed loading shovel can only take a cut of from 30 to 45 ft. and necessitates two loading cuts and placing of your tracks twice for each excavating cut.

The method of transportation of coal from the pits to the preparation plant is by no means standard or the same, but varies in almost every mine. This variation, however, has come about in the last 5 or 6 years, and in my opinion this field offers more direct comparisons of varied transportation systems than any other district. The older and almost standard practice was to load into 2 or 3 ton narrow gauge cars onto a track located along the high bank side of the cut, directly on the top of the coal, using 14 to 21 ton steam locomotives for motive power. We now find that a few are still using this system; others are using the same system except 7, 10, and 20 ton cars are used, some standard gauge with car capacities up to 40 tons, using 40 to 45 ton steam locomotives, which equipment is located in the pit and the tracks laid to one side of the cut on the coal. You then see all of these various kinds and types of equipment located on top of the surface alongside the edge of the pit. This system removes the tracks from the pits and the coal is loaded into large skips by the loader and hoisted by a portable crane on caterpillars to the cars on top of the bank. This method is very advantageous to some mines, more so when it is impossible or impracticable to have an incline or entrance to each end of your pits. Also this system eliminates casting your overburden over your haulage track and the hauling of trains by your excavating shovel, which causes quite a delay and the loss of yardage.

We then go a short distance and find that another operator is using a very different kind of transportation; that he is using trucks to transport his coal to the preparation plant and has entirely eliminated tracks. We find he is using small trucks such as the size of Fords and Chevrolets pulling a semi-trailer with automatic bottom dump doors having a capacity of 6 tons per load. These trucks pull alongside the loader, are loaded and pull out grades of 5 and 6 percent for a distance of 700 and 800 ft., and to a preparation plant three miles away. It is surprising the number of trips per day that can be made with each truck. The first impression is that it is very expensive, but after making a very thorough investigation, we find that this method compares very favorably with modern track haulage, as it is very flexible. To change your loading position in the pit is very simple, as there is no track laying to be done, no passing tracks to be laid, and you find that road maintenance is cheaper than railroad maintenance.

We also find other operators using large trucks carrying 12 to 14 tons per load, some of the trailer type, others with regular dump bodies, some small trucks carrying 2 to 3 tons loads. These trucks in most instances haul their loads over a bench of coal left along the high bank side of the pit, while others haul over the bottom and load out the entire pit. This depends upon the nature of the strata under the coal, whether it is hard or soft.

Each of these varied systems of haulage have their advantages, and there can not be a hard and fast rule as to which one to use, as you can find the same operator using a different system at each of his own mines. I think that they should be complimented in being open-minded and wise enough to adopt the system that is applicable to the mine in question.

We now go to the preparation plant and see what is being done there. We find that the same practice is almost universally used. A hopper is built below the ground having a capacity of from 25 to 200 tons. Where the coal is dumped from the cars or trucks, a conveyor is used to convey the coal to the top of the preparation plant. A crusher is located there to break any large chunks or is adjustable to crush the coal to almost any size. The coal falls upon shak-

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* Sinclair Coal Co.

Making Falls Safely

By D. A. Reed*

THE ROOF in the Elkhorn Division of the Consolidation Coal Company is of a very dangerous character. During the years this division has been in operation more than the average number of minor accidents and fatalities has resulted from roof falls. This division lies in the eastern Kentucky field in Letcher County.

The Elkhorn seam is mined in this division, and consists of two benches of coal with a parting between, both coal and parting being variable in thickness. Above the coal is draw slate, and above this a limestone formation. There is practically no bond between the draw slate and the formation above. The limestone is difficult to break and usually there is more than 20 ft. extending beyond the end of pillar. This, together with the variable thickness and structure of the coal seams, middle parting, and drawrock, makes safe pillaring difficult.

These difficult conditions, which lead to poor extraction of pillars, are invariably increasing in their bad effect. Leaving large stumps and timber sufficient to prevent good breaks in the overburden cause weight to increase over the pillar line and places adjacent. Our soft parting will squeeze under such conditions, permitting the top bench and draw slate to give sufficiently for the draw slate to become a free divided mass of dead weight on timbers and butt-off wings. To overcome these conditions would make pillaring less hazardous. We, therefore, began experimenting with different methods of timber removal.

Hand-operated post pullers were the first steps toward pulling timbers. Several types of post pullers were purchased, both the ratchet type and the jack type. It was found that, even though very slow, these post pullers showed remarkable results in making falls on our pillar lines. We used a two-man crew to operate these pullers, consisting of an experienced timberman and a helper. This work was closely supervised by the section foremen on their various sections. Only experienced men with excellent safety records were authorized as timber pullers. The greater portion of our timbering is done by cross-collaring with legs under each end. These sets are erected in a substantial and workmanlike manner and are very difficult to remove after weight has come on them. The greatest difficulty encountered with the manually operated timber pullers was in their limited capacity to pull more than one leg at a time. Consequently, as soon as this leg was pulled from under one end of the collar, the head coal and draw slate would begin to fall, which prohibited the men from making a hitch on the other pieces of timber. In other words, we were recovering one stick of timber and losing two and not accomplishing everything desired; however, we were pulling the timbers in most instances which allowed the falls to come.

Our next step was to convert old shortwall mining machines into power-driven timber pullers. These machines proved to be a distinct step in the right direction, as they enabled us to recover practically all of the timber that it was necessary to pull to make good falls. In converting these old-type machines into post pullers, we merely removed the cutter bars and chains and utilized the power-driven feed drum with the feed rope to pull the timbers. A ring with several chains was fastened to the end of the feed rope, the chains were hitched to the several timbers that were desired to pull, machines started with feed drums in low gear until timbers were broken loose, then thrown into high gear to pull them back in the clear before the fall came and covered them up. Although this scheme was far ahead of the hand-operated puller, we experienced great difficulty in salvaging all timbers on account of the slowness with which the machine pulled the timber back in the clear, even in high gear. Our crews, with the converted mining machines as pullers, consisted of four men, one of which was a section foreman, who directed and supervised all the work of pulling timbers.

of locomotives was the fact that should the pull rope be broken, a loose end would fly back and injure the operators or some of the other workmen connected with this particular job. To overcome this, we equipped all our locomotive pull ropes with a short safety link or fuse rope, also safety snatch blocks. This link or fuse, being the weakest link in the chain, so to speak, has one end fastened directly to the locomotive and the other end to the pull rope. If pull enough is exerted to part the pull rope, the safety link or fuse is parted at the locomotive, and rope flies toward the timber being pulled instead of toward the operator. We have set up very clear and definite rules to govern the actual work of pulling timbers. One that should be mentioned at this time is that no pull is made until all men in the crew are in the clear and outby the locomotive, except the foreman, who finds himself a safe place from which to observe the operation. The crew consists of a working section foreman, an authorized motorman, a timberman, and a timber helper. The section foreman and timberman are picked from the mine organization to do this work. They are men who have good records for safety, and are conscientious

	MINE 204						MINE 206					
	FEBRUARY			MARCH			FEBRUARY			MARCH		
	Recovered		From yard	Recovered		From yard	Recovered		From yard	Recovered		From yard
Posts	5,734	....	6,083	6,338	....	8,092	5,211	....	3,296	6,296	....	4,798
Percent Rec......	.....	48.5	.....	.....	43.9	.....	.....	61.2	.....	.....	56.7	.....
Crossbars	1,295	....	1,281	1,812	....	1,883	446	....	557	587	....	674
Percent Rec......	.....	50.3	.....	.....	49.0	.....	.....	44.4	.....	.....	46.5	.....
Total Crossbars & Props	7,029	....	7,364	8,150	....	9,975	5,657	....	3,853	6,883	....	5,472
Percent Rec......	.....	48.8	.....	.....	44.4	....	.....	59.4	.....	.....	55.7	.....
Sawed Caps & Wedges	6,986	....	9,745	7,662	....	10,729	6,911	....	8,102	9,065	....	13,995
Percent Rec......	.....	41.7	.....	.....	41.6	.....	.....	46.0	.....	.....	39.3	.....

TIMBER RECOVERY—1932

From our experiments along this line, we have decided that a specially designed timber-pulling machine is much needed. This machine should be so constructed that a powerful steady pull will be exerted on the pull rope when breaking the timbers loose, then an arrangement must be made in the gearing whereby when the timbers are pulled loose from their positions they can be pulled back in the clear at a relatively high speed, to prevent the fall catching the timbers as well as the hitchings.

Pending the manufacture and marketing of a suitable power-driven timber-pulling machine, we are now using a 6-ton cable-reel gathering locomotive, especially equipped to pull all timbers in all of our mines. This outfit has proven by far the most satisfactory set up we have ever had.

Inasmuch as safety engineers from time to time have frowned upon the use of a locomotive to pull timbers, we set out to make our operations as safe as possible. The main objection to the use

workmen, with long experience. The foreman is a strict disciplinarian. He directs and supervises all the work, while the timberman, who is an expert in his line, makes all the hitches on the timbers to be pulled.

These timber-pulling crews have a specially equipped tool car for transporting their equipment and supplies. The car has a built-in toolbox, permissible explosive and detonator boxes insulated and protected in a manner to satisfy the safety department.

Extra ropes, fuse ropes, chains, timbermen's tools, and other items which have been found necessary by experience are carried in the tool car; also explosives and detonators in limited quantities for use when necessary to shoot out timbers and stumps not otherwise recoverable.

Another tool which is provided to reduce the hazard of salvaging timbers, which may have been used for lagging, cap pieces, and wedges, is a section of

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* Division Manager, Elkhorn Division, The Consolidation Coal Co.

Accident Prevention - A Vital Problem

By Lee Long*

IT IS EVIDENT that my audience is made up of men interested in the subject of accident prevention. It is a happy privilege and a distinct honor, as well as a responsibility that I recognize in attempting in my humble way to make a statement dealing with this important matter as a basis for discussion of this subject.

So much has been written in the past by men amply qualified to cover every phase of the subject, from the standpoint of benefits that come to employers and employes in industry in minimizing personal injuries that result from work accidents, it is difficult for me to find, without repetition, anything really worth while in the way of new thoughts to express or suggestions to make that would add to your realization and appreciation of these benefits as executives and management representatives of industry.

Suffice it to say: The prevention of accidents is (1) a solemn service that management owes to the worker; (2) a solemn service that management owes dependents of the worker; (3) a solemn service that management owes the community, county, State, and Nation; (4) a solemn service that management owes to owners of industry, because management knows that accidents represent a major waste to all concerned in industry. The worker also owes a solemn service to his dependents, his fellow worker, and his employer.

It appears proper for me to state that my experience, covering a period of more than 35 years, has been in connection with coal-mine operation exclusively, an industry that is carried on under conditions that are generally regarded as being among the most hazardous.

Perhaps it may be just as well to start by relating to you story of accident-prevention activities conducted by the Clinchfield Coal Corporation management, beginning with the year 1918, a little more than 14 years ago, with an average of eight mines operating in Virginia during this period, three of which are located in Dickenson County, four in Russell County, and one in Wise County.

The average number of workers employed has been approximately 2,000.

The average annual production has been about 2,000,000 tons. Mining conditions are about the same as are found in Virginia, West Virginia, and Kentucky fields, taking the average.

In 1918 the Virginia workmen's compensation law was enacted. It was then that we began as self-insurers under the State compensation act to organize for the prevention of accidents. It has been a long, hard pull, and we have not produced results of which we have any special reason to be proud.

For some years prior to 1918 we were active in training workers in first aid, and this training has been continued to the present time, having conducted several campaigns under which our employes were given first-aid training 100 percent. However, fully realizing the importance of first aid, we concluded that first aid to the injured was secondary in importance to first aid to uninjured.

Being among the first employers in our field to start accident-prevention work in an organized way, we found that it was necessary to experiment considerably, but learned gradually by experience, from the very beginning, that our efforts were rewarded and amply justified, although we occasionally had cause to be discouraged.

Feeling that you may be interested, I will give you the set-up of our accident-prevention organization, which is as follows:

1. Mine-safety inspector who makes regular bimonthly inspection and reports immediately on dangerous conditions and dangerous practices observed.
2. General safety committee at each mine, made up of superintendent, general foreman, and assistant foremen, who meet weekly for discussion of accident problems.
3. Safety committee in each mine, composed of four to seven members, depending upon the size of mine and number of men employed. Each safety committeeman is required to be on the lookout for dangerous practices and dangerous conditions at all times, reporting to the general foreman or assistant foreman of section where failure occurs. All employes, particularly safety committee, are invited to make safety suggestions, which are considered by committee made up of general superintendent, superintendent, general foreman, and industrial claim agent, who has general charge of accident-prevention work as secretary. This committee reviews all suggestions once each month and awards prizes commensurate with value of suggestions.
4. All fatal and serious accidents are immediately investigated by general superintendent, general inspector, superintendent, and general foreman of mine in which accident occurred.

Once each month a general accident-prevention meeting is held at each operation, when all details relating to accidents (if any) that occurred during previous month are discussed and witnesses questioned; the chairman of the meeting having been furnished with map prepared by engineering department, showing scene of accident. When possible, the injured man is required to be present at monthly meetings.

As a means of creating and maintaining interest in attendance, prizes are awarded, and sound pictures are frequently provided as entertainment at monthly meetings.

Each mine is supplied with Elliott Safety Bulletin Service. Bulletin boards especially designed to display Elliott posters are used. Each employe making up personnel of supervisory forces is provided with Elliott Service Letters, dealing with various phases of management, featuring accident prevention, efficiency, and the importance of avoiding waste.

Now, for methods finally adopted in accident-prevention work: Foremen are rated on their accident records. By study of records over period of years by classification as to causes, we found the following:

	Percent
Falls of roof (slate and coal)	52
Transportation	23
Handling materials	10
Mining machines	6
Coal drills and hand tools	6
Miscellaneous	3

Having determined that 52 percent of fatal and serious accidents are caused by falls of roof and coal, it was obviously essential that a special effort should be made against this class. The campaign actively carried on against this type of accidents attracts the attention of all foremen to the necessity of maintaining active interest and bringing about adequate participation on the part of each and every foreman, as well as all workers. The potential risks due to failure of judgment on the part of foremen and individual worker is also stressed. The question of discipline is generally left with the general superintendent and mine superintendent. When investigation shows that accident resulted from failure of supervision, the man responsible is apt to lose his position.

We carefully analyze every item of cost due to the occurrence of accidents. We have managed to keep costs down to what might be regarded as a reasonable figure; however, if we are able to reduce this item of cost by one-half, we will not be satisfied, and we are now demanding of our supervisory forces that severity and frequency of accidents must be substantially reduced. Our cost per ton for compensation, hospitalization, and medical during 10-year period, 1921-1930, has averaged .0267 cent. For the year 1931 the cost per ton was .0153 cent.

Frequently those of us who are interested in and making a study of accident prevention get inspiration from speakers heard on the subject and from records that come to our notice showing outstanding accomplishments by certain organizations headed up by men with whom we are acquainted, but after all we can all get the inspiration required by simply making a careful study and analysis of the monthly statement such as we find on our desks each month showing, (1) number of compensable accidents classified as between fatal, serious, and slight lost time; (2) cost per ton current month; (3) cost per ton fiscal year to date, each month separately; (4) cost per ton previous year, each month separately; (5) total cost in dollars and cents previous year; and (6) total cost in dollars and cents over period of last preceding five years, which figures are sure to create in the minds of management ample incentive for a definite determination to do a better job in future. Management should take the very definite position that accident prevention is the right thing to do. That the workers

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* Vice President, Clinchfield Coal Corporation, Dante, Va.

Safety in Blasting Coal—Cardox

By J. E. Jones*

ONE of the most interesting studies in the history of mining is that of "Blasting." Its evolution is resplendent with experience and research, both of which could give to history a record of cost as gory and heroic as that of a battlefield.

In a study upon this subject one is most apt to give thought to the purpose, to its beginnings, and to the reasons for progress. I have often pondered upon the courage of the first person who prepared a powder charge and made the first blast in a coal mine. We have no record as to who he was, or what happened. We do know that there was a thrill in the adventure. Probably the incentive lay partly in his inability to perform as much physical work as his comrades, thus making demands upon his thinking that he might remain in competition.

The terms "shot," "shooting," and "fire" as used in coal mining were taken from similar expressions and commands as used in warfare and with firearms. Many of us here today can remember when the terms were quite applicable and fitted very well. Our mining laws upon blasting are the result of those experiences, made in an effort to compel practices found to be of the least hazard.

It would be difficult to coin another word that would give the meaning conveyed when "fire" is shouted just prior to the blast. By it is meant for persons within the danger zone to get to a location of safety from flying material, whether on the surface or in a mine. The ordinary definition of the word fitted into coal mining because in addition to flying particles, fire was itself an added hazard. To reduce and possibly remove this hazard has been the object of good practice and scientific research for half a century.

Safety and efficiency are analagous terms in all industrial progress. Possibly in no other field than that of blasting have these two been of such fundamental importance. The energy concentrated, and work to be accomplished, have called forth as great or perhaps greater ingenuity towards safety, and therefore efficiency, than other evolutionary processes.

The loosening and breaking down of materials from their parent locations, either for their use or for their removal, has been a problem nearly as old as civilization itself. Its history is as romantic as that of tools, transportation, or any other of mankind's industrial pursuits. It begins in the remote past and is not yet fully solved.

When materials began to be exploited, the work was done by hand tools. Other than the labor involved and slowness of procedure, this probably has never been surpassed in so far as safety to workmen and quality of product are concerned. The necessity for speedier recovery and faster removal demanded the adaptation of the explosive force of war time to peaceful pursuits. Especially was this true in the fast-growing New World, where exploration, discovery, and development were faster by far than the growth in population.

As one might expect, the very nature of blasting is fraught with danger. Possibly in no other industrial pursuit is the word "safety" so largely used. It is a modifier that is affixed to explosives, squibs, fuse, and even to certain practices. Much of this has been caused by overzealousness resulting in confusing "less dangerous" with "safety." The wish has often been the father of the thought. As great an authority as Alfred Nobel at first claimed that his blasting oil, "nitroglycerine," was a safe explosive—that it could hardly be made to detonate except when struck a heavy blow or when confined and ignited by a suitable igniter.

In days gone by some manufacturers were prone to believe and broadcast a false standard of safety with respect to their explosives—but now that the inherent danger is better understood, greater and more intelligent precautions are taken and accidents from manufacture and use have been much reduced. The lessons learned have been of assistance in the development and use of the device which forms the subject that has been allotted to me.

Even a brief story upon the evolution of "blasting" would be too lengthy for the time at my disposal here. In lieu of such a story I want you to consider a theoretical blasting medium which has 100 percent of the hazards that can pertain to the blasting of coal. From this maximum of hazards I wish to eliminate them one by one in an effort to approach a 0 percent of hazards.

This theoretical substance is handicapped:

(1) By the property of extreme inflammability, not only an initial ignition but propagative, endangering safety from conflagration and explosion of the substance.

(2) By susceptibility to shock, its instability easily resulting in premature explosion.

(3) By disintegration, possibly changing the substance from an explosive to a slow-burning compound.

(4) By necessity of expert attention and handling, a condition apt to be occasionally overlooked due to the large number of blasts required and the large number of men employed.

(5) By overcharging to guarantee complete breakage, thereby resulting in overblasting and resultant flying material.

(6) By ignition of blasted coal, firedamp, or coal dust resulting in mine fire or explosion.

(7) By poisonous or otherwise obnoxious gases, and smoke.

(8) By a destructive force affecting other than the material blasted.

(9) By unsuccessful detonation entailing a hazard of removal, or hazard of its loss in coal shipped.

(10) By ignition of fire-damp from detonator.

(11) By premature detonation in transportation or handling.

All of the foregoing 11 points apply to my theoretical blasting substance in its storage, transportation, preparation, use, and physiological effects.

I now assume an assignment to myself giving authority to demand requisites to eliminate the hazards, these to approach a hazard percentage of zero. Having such authority, it is logical that my first and greatest demand is to employ a noninflammable, therefore nonexplosive, substance. In this one demand I eliminate most of the hazards under ignition and explosion in the transportation, storage, handling, and use of the substance.

My second requisite would be discharge without flame. Requirements Nos. 1 and 2 would wholly remove the fire and mine explosion hazards from blasting initiation. The disaster hazard also would be eliminated. Except for the physiological effects and perils from overcharging, all of the 100 percent hazards would thus be removed.

Most of the physiological hazards and the smoke hazard are eliminated because combustion, and therefore the products of combustion, is removed by my first demand. To complete the removal of such hazard my third demand would be the use of a substance harmless to respiration.

To offset perils from overcharging, my fourth requisite would be a unit charge, a certain definite amount of energy for each mine that could not be added to nor subtracted from; and further giving no disrupting effect to materials in the solid because of the slowness of the blast.

A fifth requisite would be necessary, that of no susceptibility to shock, thus permitting handling without fear of premature blast.

I can conceive that with these five requisites, the blasting method resulting would approach the 0 percent of hazards as closely as the use of average tools, and closer than that of some tools. I do not know of any blasting principle that wholly conforms with this imaginary standard. Cardox, in my opinion, is an approach embodying to a large extent the requisites I have assumed.

The first, third, and fifth of my imaginary demands are wholly complied with in the Cardox system of coal mining. The carbon dioxide used is noninflammable, nonexplosive, nonpoisonous, and is not susceptible to shock. The percentage of CO_2 resulting in the atmosphere at the location of the blast and immediately following it is so small as to be considered negligible.

Compliance with my second imaginary demand is not wholly met, for electric ignition is used. There is, however, a very close approach complying with the permissibility requirements of the United States Bureau of Mines. The heating element is surrounded by the CO_2 under many atmospheres of pressure and its function is performed inside of the steel cartridge in a substance that is wholly noncombustible. The luminous particles

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Power Problems

F. S. Pfahler

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Mechanical Loading

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Safety in the Use of Permissible Explosives

By H. L. Griffin *

THE term "permissible explosives" had its origin about the year of 1908 when the United States Government began to test explosives for safety in use in coal mines. Somewhat previous to that time countries abroad had demonstrated that explosives of the dynamite classes offered greater assurance of safety from the danger of igniting fire damp than black blasting powder, due to the fact that in order to ignite fire damp it is necessary to have a flame which produces enough heat to raise the fire damp to the ignition temperature. As the heat transfer from the flame of a detonated explosive to an explosive mixture is a function of both time and temperature, it was found that even though the flames from the dynamites were the hotter, the duration and penetration was much less than that of black blasting powders, hence the conclusion above stated.

Much valuable research and testing was done after this meagre beginning was made about 24 years ago from which rapidly evolved our numerous strengths and brands of permissible explosives manufactured today by the various explosives companies, having quick, short, and comparatively "cool" flames.

As my audience, without a doubt, is thoroughly familiar with the United States Bureau of Mines permissibility tests, I will not here bore them with any detailed description, but refer those who desire this information to the publications by the Bureau on this subject. Suffice it to say that the Bureau's tests are thorough and as complete as modern practical testing methods permit, and they are always anxious to cooperate in every way possible to advance the efficiency and safety of mining.

Due to the relative safety of permissible explosives, especially when used where there is a chance of an accumulation of explosive gases, along with their apparently ever-increasing efficiency, the production has steadily grown in relationship to the annual production of coal, as shown tabulated below:

Year	Production of coal	Pounds of permissible explosives sold to coal mines	Pounds of permissible explosives per thousand tons of coal mined	Percent of all explosives used represented by permissible explosives
1905	392,722,635	1,031,300	3	Not given
1910	501,596,378	11,820,836	24	Not given
1915	531,619,487	21,841,659	41	10.3
1920	658,264,932	45,222,130	69	15
1925	581,869,890	52,256,042	90	24.7
1930	531,432,000	52,378,341	99	31.6

Although we have not, and possibly never will, reach perfection in our earnest desire to eliminate all accidents in our coal mines, safety, if kept uppermost in the minds of management and personnel around our mines, I believe, will continue to eliminate more and more of the accidents which we now have. However, we may feel some pride in the fact we have never, according to my information, had a major catastrophe caused by the use of permissible explosives when used as prescribed by the United States Bureau of Mines.

Relative to the specific subject of "Safety in the Use of Permissible Explosives," much has been written, and it is not easy to add thereto without becoming trite and boresome. In general, safety in the use of permissible explosives is increased by the following characteristics of the explosives themselves:

(a) Its lack of sensitivity as regards to accidental detonation in handling; (b) its ability to be stored under reasonably good conditions and the addition of ingredients making it nonfreezing without deterioration as to effectiveness; (c) its degree of inability to ignite explosive gases when detonated in the presence thereof; (d) its certainty of detonation when properly charged in the bore hole and exposed to the action of a properly placed electric detonator; (e) its uniformity in quality and weight per stick or cartridge and the resulting uniformity of performance from the use of similar amounts of explosives under similar conditions of burden or work to be done; (f) the amount of noxious and objectionable gases given off; (g) its resistance to moisture; and (h) its resistance to ease of ignition. These characteristics have been brought to such a point of perfection by the explosives manufacturers in conjunction with the requirements by the United States Bureau of Mines for permissibility until we now have a product which is quite safe to use under proper regulations and supervision.

"Safety in the Use of Permissible Explosives," it seems to me, can be best divided under the following headings:

(a) Receiving and storage; (b) distribution and transportation to working face or sections of the mine; and (c) use as regards inspection and supervision, including placement of bore holes, priming, charging, proper tamping and detonation of bore holes, and effect of use on other hazards such as roof weakening resulting in roof hazards and the like. These subjects, aside from possibly storage, are all safely varied within limits, many of them necessarily so, to fit: First, particular conditions of texture, hardness of structure, and other characteristics of the various seams of coal; second, to meet different natural conditions found in each definite seam; and, third, to meet the demands of various methods of mining used by different operators. As a consequence of these varying conditions the number of detailed methods compound rapidly and become numerous, so numerous, in fact, that it would be presumptuous, indeed, for one to go into great detail in such a short paper. Therefore, the following remarks will be of a general nature only.

Receiving and Storage in Main Magazines

Explosives are commonly received in either carload or ton lots by rail or truck. With either method of receiving, explosives should be stored in a properly constructed magazine which should be of incombustible material, well ventilated, and provided with suitable locks. This magazine should be of bullet-proof construction and so located as to meet with the provisions of State laws and underwriters' requirements. Permanent danger signs or placards should be posted at the magazines and along all roads and paths to same as a warning to persons who might approach them. Explosive cases should be stored in the magazine top side up, and never close to walls or to steam pipes. The order of storage should be such that old stock can conveniently be used first and not more than six months supply of permissibles should be purchased at one time, less whenever possible.

Under no conditions should electric blasting caps be stored in the same building with permissible explosives, consequently a magazine of similar construction should be provided for them at a safe distance from that in which permissible explosives are stored.

Distribution and Transportation

The distribution magazine should contain only one day's supply at any time and should be similar in construction to the main magazine. Transportation to the working place or section may be safely conducted by means of properly constructed insulated cars provided for that purpose or by the individual miner in suitable containers, which should be approved by the departments of mines of the various States. Where explosives are stored in bulk inside the mine, suitable magazines should be provided at locations convenient to points of consumption. When stored in individual containers underground cubbyholes of sufficient size should be provided at safe distances from the working face.

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Safe Handling of Explosives at the Working Face

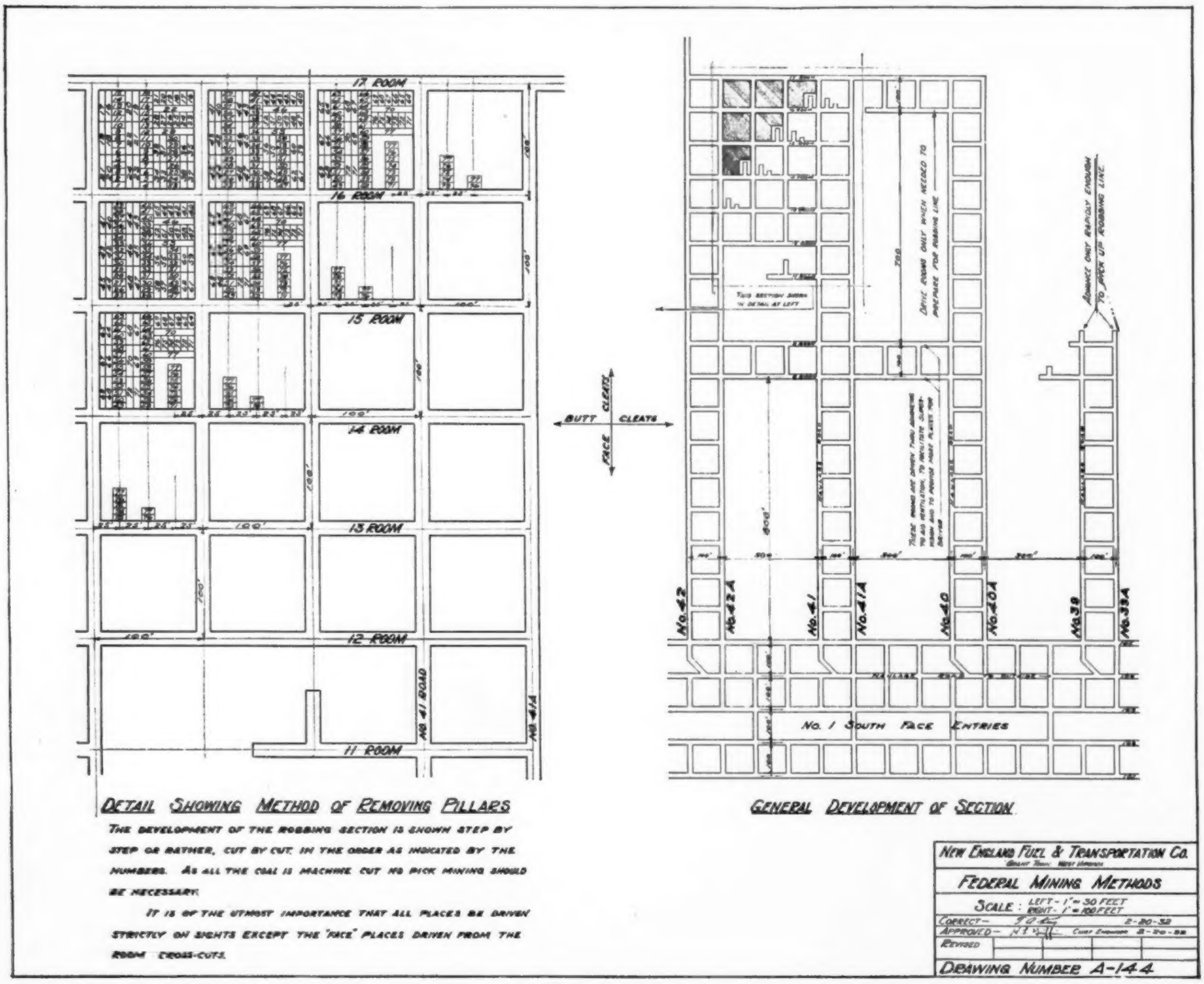
To insure maximum safety at the working face certain procedures must be followed. The methods used may vary according to local conditions but certain general principles obtain regardless of the seam of coal. Proper placing of bore holes is a very important factor both from a safety and execution standpoint. The physical conditions of the working face such as roof and floor, nature of the coal, method of mining, blasting and type of explosives used must be a consideration. In fact these variables are so extensive and adverse that particular studies must usually be made in order to obtain the best results. In conformity with the results of these studies complete blasting standards should be drawn up and rigid enforcement of the rules compiled in such standards should be insisted on, which means thorough supervision and frequent inspection.

Use as Regards Supervision, Inspection, etc.

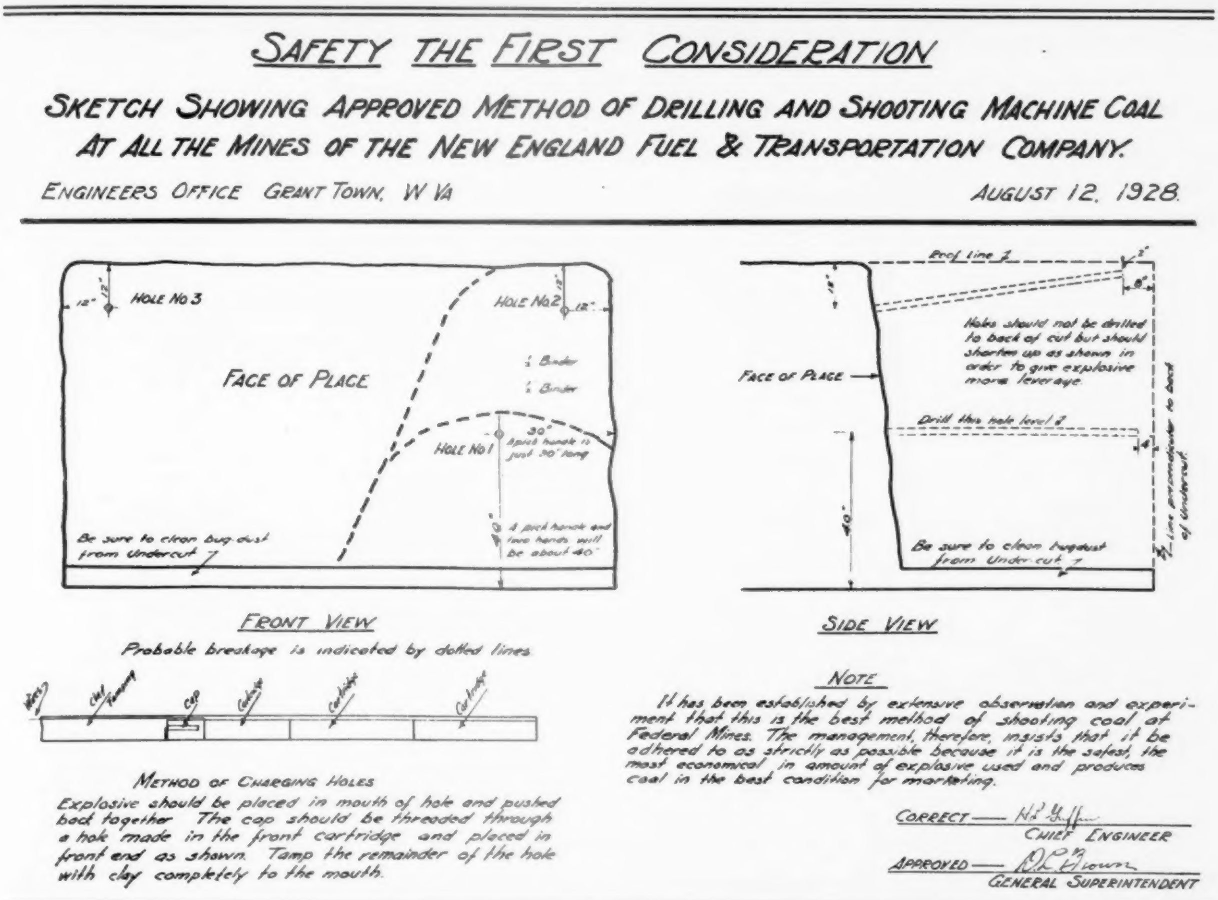
In gassy or dusty mines only well trained men should be employed to prime, charge, tamp and fire shots and they should be provided with proper equipment for the safe performance of their work and in the absence of state regulations, vested with authority by the officials, to refuse to charge or fire any place where the proper preparations have not been made. A record should be kept giving reasons for such refusal and a report made to the officials in charge. Only one hole should be charged and shot at a time and then only after the dust is completely allayed and the absence of explosive gas is ascertained by means of an approved flame safety lamp. The face should be again inspected after each shot is fired for gas, fires, effect of blast and roof conditions. The shotfirer, of course, should be under the supervision of a certified section boss, assistant mine foreman and mine foreman, and subject to their authority. The above represents broad basic principles which can be followed in practically all coal mines. Due to the great variation of methods required by varying conditions and mining systems it is impossible for the writer to discuss any system that would be adaptable to all mines. Therefore we will only endeavor to treat "Safety in Blasting Coal with Permissible Explosives," as carried out at the Federal Mines of the New England Fuel & Transportation Company, located in the Fairmont-Morgantown fields of which I am familiar.

Practice at Federal Mines

The New England Fuel & Transportation Company operate two mines in the Pittsburgh or No. 8 seam of coal in the above named fields. Federal No. 1 mine at Grant Town having a daily production of about 7,800 tons is the largest single producer in West Virginia while Federal No. 3 mine at Everettville has a production of about 3,000 tons per day. The methods of mining are identical at both properties as are the regulations for handling and use of explosives. The seam averages about 8 ft. 6 in. in height of which from 7 to 7½ ft. is mined. From 8 in. to 1 ft. of roof coal is left up to protect and hold the top. The coal has the well known "three foot" or "bearing in" binders which regularly appear in the Pittsburgh No. 8 seam, though they are not as prominent as usually found. It has pronounced face and butt cleats, the former being the larger.



The overlying and underlying strata is much like that customarily found in connection with the Pittsburgh No. 8 seam; the floor being fire clay and the roof consisting of from 6 in. to 3 ft. or more of drawslate, averaging about 18 in. to 2 ft., which disintegrates rapidly on exposure to mine air. Over this usually is found a rider coal from 3 to 12 in. thick. Above this rider coal horizon we generally find a stratum of clay or clayey shale, 20 to 40 in. thick which is darker in color but not slickensided as the lower clays or drawslate, and which



is not so readily attacked by moisture. Above this to the surface are found the customary measures of lime shales, sandstones and limestones. The minimum cover is 260 ft. and the maximum is approximately 800 ft. averaging in the neighborhood of 450 ft.

A variation of the block system is used, all places including rooms, headings and cross-cuts being driven 12 ft. wide on 100-ft. centers in accordance with points set by the engineers. The detail of working pillars is shown on the attached drawing; all pillar splits except the two in each block developed on the face cleats parallel to the room, are driven on sights in order to make pillar extraction uniform.

It may appear that the method of mining aside from the width of the working places has but little to do with safety in blasting. However, this system of mining fits our natural conditions well and permits of splendid roof control, rapid extraction and concentration, making it feasible and safe to undercut all places with mining machines thereby eliminating any solid shooting. Thus only light charges are required to "pull" the coal and as a result little or no effect is shown on the roof from blasting.

These mines are electrically equipped, worked with closed lights and employ carefully selected shotfirers. Approximately 570 miners are regularly employed at both mines in producing the above daily tonnage. In the last five years Federal Mines have produced 8,520,482 tons of coal, of which, No. 1 mine produced 5,847,827 tons and No. 3 produced 2,672,655 tons during which time there has not been a single accident that could in any way be attributed to explosives, directly or indirectly. This record is no doubt due principally to enforcement of rules governing the storage, transportation and use of explosives.

Explosives are delivered by rail in carload lots and stored in our main magazines, from which daily consumption requirements are removed to the distributing magazine. Electric detonators are delivered to the magazines by truck monthly. Daily requirements are put in approved leather containers and distributed to the shotfirers. All cases are opened by use of wooden wedges and mallets. The miners purchase explosive and electric detonator checks from the company store giving one explosive check for each cartridge of explosive received in the morning from the distributing magazine and giving one electric detonator check for each detonator the shotfirer uses in blasting his working place at the time of the shot, thus an accurate record is kept of the amount of explosives and detonators used each day. The explosives are carried into the mine in approved containers by the miner and on arrival at the working place are placed in cubby holes dug in the rib at least 100 ft. from the working place strictly in accordance with company rules. Electric detonators are carried only by shotfirers in approved containers who keep them on their person during the whole working time.

All holes are drilled by the miners using post or cyclone drills, and must be placed strictly in accordance with company standards under the supervision of the various officials. (See attached drawing.) The block or snubbing hole system is used as shown on attached sketch. This permits the drilling of the block or snubbing hole at the end of the shift and before the place is cut, as all cutting is done on the off shift.

Cutting is done by shortwall and mounted bottom machines and care is taken to obtain straight ribs and uniform depth. Each machine is equipped with facilities for applying water to the cutter bar from pipe lines in every working place and sufficient water is applied during the operation of the machine to allay practically all dust made during this operation.

Fireboss examinations are regularly made within three hours before the beginning of the shift and men enter the mine only after firebosses return to the surface and report the mine safe. During the day frequent examinations are made by the section foreman and other officials.

Before beginning work the miner carefully examines his working place and takes whatever steps necessary to make it safe, removes all bug dust from beneath the cut with a bug dust shovel and thoroughly washes the face and ribs for a distance of 30 ft. by means of rubber hose provided in every working place. This work is completed before the arrival of the shotfirer who upon arrival, exam-

ines the place for gas or any other dangerous condition and finding same absent proceeds with preparations for the loading and firing of the first or block hole. Miners are not permitted to handle explosives in any manner at the working face and the priming, charging and tamping is done by the shotfirer who designates the amount of explosives to be used in each hole. The methods of priming, charging and tamping are done in strict accordance with company standards. All holes are tamped their full length with damp clay with the aid of a wooden tamping bar long enough to measure the depth of the hole and under cut. Only short circuited No. 6 electric blasting caps are used and under no conditions is the short circuit removed until such time as all other preparation has been made prior to the firing of the shot. Before attaching firing cable to the leg wires of the detonator the shotfirer sees that all persons have removed to a place of safety and that all roads of approach are guarded. Before removing the short from the leg wires and attaching the firing cable he sees that the firing cable is properly reeled or spooled and that the outer ends are short circuited by twists or otherwise. Then after attaching the cable to the leg wires it is paid out to a safe distance, care being taken to see that the firing cable does not come in contact with any material which might conduct electricity. (Shotfirers are not permitted to use cables less than 100 ft. in length.) After calling the customary warning the current is applied. In case of misfire, which *very seldom occurs*, the cable is disconnected from the source of supply of electricity and the firing end of the cable is re-short circuited and it is rolled up as the shotfirer approaches the face to investigate the reason for the failure. This may be a faulty connection or a short circuit at the points of attachment. Should this be found it is remedied, the procedure above outlined for paying out the cable is again carried through, and the source of electricity is again applied. However, should the trouble not be found and the shotfirer finds that he is unable to shoot the place after several attempts the section foreman is notified and under his directions preparations are made for the drilling, charging and firing of another hole which shall be at least 12 in. from the one failing to fire. After this second hole has been fired care is taken in recovering the misfired detonator and explosive.

I might say here that at our No. 1 mine we have had no misfired detonators this year. We have had a couple of holes —I think two or three—where the explosive hasn't all gone off, due to bad placement or some other cause, but we have had no misfired detonators.

After each shot the shotfirer examines the working place for gas, fire or any other hazard and effect of shot.

The miner after the shot, again examines, washes down his working place and loads out the coal from this shot to the back of the cut and drills the second hole preparatory to the coming of the shotfirer. This general procedure is repeated until all holes are shot and the place is cleaned up. Unused explosives and detonators are returned to the magazine on the surface and record kept of them.

Each shotfirer at Federal Mines is vested with authority, subject to the direction of the section foreman, to refuse to charge, tamp or fire any holes not properly placed or where the proper face preparation has not been made. He keeps a record of and reports to the section foreman the number of shots fired, the number that he refused to fire with his reasons, and the number of misfires, if any.

The fact that we at the Federal Mines during the past five years have had no accidents which in any way can be attributed to explosives is ample proof, in the writer's opinion, that safety can be had with the use of permissible explosives, where complete standards are rigidly enforced by efficient supervision.

In conclusion I would say that permissible explosives have many advantages, the chief one being the fulfillment of the object for which they were originally developed; namely, to reduce the hazard of blasting in dusty or gaseous mines. However, the usefulness of permissible explosives is by no means limited to gassy and dusty mines as they provide a safeguard against the potential hazard of gas in so-called non-gassy mines. Present day permissibles generate very little smoke and poisonous fumes and are made in such a wide range of characteristics as to be safely adaptable to every type of coal mine blasting, therefore it is the writer's opinion that the day is not far off when only permissible explosives will be used for underground coal mine blasting.

STRIP COAL MINING IN THE SOUTHWEST

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ing, inclined screens and is divided into their respective sizes; namely, 1¼-in. screenings, 1¼ x 2 in. nut, 3 x 2 in. nut, 3-in. lump and egg, or any combination of these sizes. The sizes above 1¼-in. are passed over rescreens, sometimes vibrating screens, but usually the reciprocating type. The coal then passes over picking tables and is picked, then lowered into the cars by loading booms, and is ready for market. This is about the only part of the operations that is a standard practice throughout the field, and you can see from some of the older plants, where as each improvement has been adopted, it has been added to the preparation unit. It is my belief that washing units will be the next large step, and has already been adopted by several companies. I feel that in a short period all of the larger companies will install them.

This, I believe, covers in brief the operations of this district and its varied methods. I believe that economies and efficiencies have gone hand in hand, and at the same time every operator has improved his product which is evidenced by the phenomenal rise in the production of strip coal in this field, which has risen from 1914 with a production of 600,000 tons until 1931 with a tonnage of approximately 3,200,000 tons, or an increase of 533 percent. This rise has been steady with the exception of the strike years following the World War, which showed a decline from the war peak of 1918 for the years 1919 to 1924, inclusive, but in the year 1925 passed the peak of war-time production and has shown an increase every year since with the exception of 1930 which held its own with the former record of approximately three million tons for the year 1929. As you follow the graph, you can see that 1931 in face of the worst depression we have seen, showed an increase over 1929 or 1930 of 6 2/3 percent. One must also realize that this district's market has had more competition from oil and gas than probably any other district, due to its proximity to the largest producing oil and gas fields in this country.

This expansion at this time is only possible by the economies and efficiencies that have been effected, the better and improved product which has been accomplished by the production departments, and the true fighting spirit of the men that are responsible for the marketing of this production.

ENGINEERING AS A FACTOR IN SUCCESSFUL OPERATION

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To me, this indicated that here wàs a man so efficient in his work that he was doing more than his share with such apparent ease that he fooled the boss, and that here was a boss who didn't appreciate the principles of modern management and production methods as well as the man who was working for him. I therefore close my remarks by saying that to get the benefits of engineering in successful operation, the old-time superintendent, mine foreman, section foremen, etc., must learn the principles of engineering and time study and their application, and when this is accomplished the mystery about coal mining will be gone and coal mining will be able to take its place among other efficient industries without having to apologize for itself.

ACCIDENT PREVENTION—A VITAL PROBLEM

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should share the problems. Get the workers to think with management. Find out what the other fellow thinks. Management and workers are on trial, so to speak. When you run into trouble, go after it where it is. Face the facts. Work on both sides and all sides.

Just a word with reference to the picture you get when you have a large organization. When you see your accident costs, even with a fair record, when you employ as many as 1,500 or 2,000 men, the dollars and cents run into a good many thousand dollars per year. I don't know of any activity that will yield more return for the effort than what it is possible to do in the reduction of accidents, and thereby save a large amount of money. After all, not losing sight of the humanitarian phases and otherwise, if you are able, by your efforts, to reduce to a satisfactory figure—we know we must have some cost for that item—the cost of your accidents or the money that you have to pay out as a result of them, all of these other humanitarian and other phases take care of themselves.

In conclusion let me say that accident prevention must have the support of each and every employe in the organization, from the chief executive down. However, the bulk of the responsibility rests upon superintendents and foremen on the job. Maintain active interest, insist upon the exercise of good judgment, take no chances, be faithful, and the record should be reasonably satisfactory.

Electrical Maintenance Problems

By B. H. McCracken*

WITH the widespread application of electricity in present-day coal mining, the problem of maintaining electrical equipment assumes more and more importance. There is hardly an activity connected with modern mining which is not or can not be performed with electricity, the equipment for performing this service becoming more and more complicated. The day of the combination mechanic and electrician is past. There is an absolute necessity for men who are trained to handle the maintenance of electrical equipment alone. Coal is cut, drilled, shot, loaded, transported to the tipple, prepared and loaded for shipment by the use of electricity. There is, of course, the necessity for mechanical ability in most of the applications of electricity due to the various activities, but the necessity of expert electrical knowledge is of paramount importance at electrical mines.

In discussing problems to be met at an electrically operated mine, the subject naturally divides itself into five phases, which we will discuss briefly as follows.

1. Selection of proper equipment.
2. Maintaining adequate power at the points of usage.
3. The proper operation of equipment.
4. Inspection.
5. Repairs.

Selection of Proper Equipment

The importance of the proper selection of electrical equipment can not be overstressed. Too often equipment is purchased and installed to do certain specified work which is not at all designed nor properly adapted to the service intended. This may be the result of the desire to standardize with equipment already in service or it may be that too little thought is given to the application of the equipment. At any rate, the fact remains that considerable equipment is misapplied, with the resulting high cost of maintaining it. As an example of misapplied equipment we offer the following:

At a slope mine producing 3,000 tons per eight-hour shift the grade against the loads to the outside averaged about 3 percent. Three tandem locomotives, each consisting of two 10-ton units, were used to haul the coal, each locomotive handling trips up to 25 cars. The haul was about 12,000 ft. one way, and each locomotive made eight trips per shift at an approximate speed of 5 miles per hour loaded. This equipment was so badly overloaded that the life of armatures was about six months, and wheels had to be turned or replaced every four months. It was the practice to turn the wheels twice before replacing. After a thorough study of this haulage two 40-ton tandem locomotives were installed, each consisting of two 20-ton units. These locomotives handle up to 50 cars per trip at approximately 10 miles per hour loaded, and make from 9 to 10 trips per shift. This equipment has been in service three years, during which time there has been no electrical expense except trolley wheels and no mechanical expense except brake shoes. The wheels have not yet been turned the first time. This example shows very clearly how misapplied equipment may result in considerable cost. Replacing three locomotives with two resulted in saving one crew, and the saving in maintenance was, to say the least, considerable.

The same reasoning will apply to any other type of electrical equipment whether it be mining machines, locomotives, pumps, hoisting equipment, fan drives, or substation equipment. If the equipment is designed to meet the operating conditions and has ample capacity, considerable breakdown delays will be eliminated during its life, with the resulting saving in maintenance expense.

Maintaining Adequate Power at the Points of Usage

Little need to be said on the subject of keeping a good power supply at the points of distribution. This problem has been the subject of numerous papers before this body and has been very completely covered. Suffice it to say, therefore, that the importance of maintaining a proper and adequate power supply is second only to the proper selection of equipment if the problem of maintaining electrical equipment economically is to be solved satisfactorily.

The Proper Operation of Equipment

After equipment has been correctly selected and proper conditions maintained, it is of the utmost importance that it shall not be abused. So long as coal is mined there will be emergencies necessitating the abuse of equipment; however, it is becoming more and more a recognized fact that the first step in properly maintaining electrical equipment is to see that that equipment is correctly operated. The time is passing when mining officials considered the maintenance man's primary function was to repair equipment after it had failed, and more and more the organization which is charged with maintaining equipment is being consulted by the operating officials towards obtaining better operators and those conditions under which a given piece of equipment will be properly handled. It is only logical that such a condition should exist. As the use of electricity becomes more extensive in mining and the necessity of obtaining minimum operating costs becomes more imperative, there is considerable saving to be effected if improper treatment of equipment, which results in failures and, therefore, expense, is reduced to a minimum. There would be considerable equipment failures prevented in practically all electrical mines if improper operation could be eliminated.

There are many ways of abusing equipment. Locomotive operators often set the brakes to stop slipping wheels, resulting in near short circuit across the armatures; they also are frequently found to use the reverse for stopping under conditions other than emergencies. Pumpers often install too small discharge lines on field pumps, resulting in overloaded motors. Mining-machine operators are prone to allow bits to become too dull, resulting in overloaded motors and overstressed mechanical parts. Operators of locomotives, mining machines, pumps, and other portable equipment are frequently lax in lubricating, etc.

A very effective method of reducing common abuse of equipment is to have employes' schools of instruction, in which operators are given a thorough lecture course in the fundamentals of the proper operation of their equipment. Instructors familiar with the various kinds of machinery outline to the men their duties and responsibilities and discuss with them their problems. This procedure results in employes trained to properly operate and care for equipment entrusted to them. Qualified men are given certificates to show that they have received instruction and have satisfactorily passed oral examinations covering the operation of their equipment. Thereafter detection in the abuse of their equipment results in the cancellation of their certificate. This system, therefore, provides a basis for weeding out undesirable men.

Inspection

Regular and thorough inspections at stated periods are necessary if electrical equipment is to be economically used. This kind of equipment has a tendency to develop trouble if allowed to operate over long periods without inspection. Accumulations of dirt and oil are injurious to windings, copper dust leads to grounds, and bearings must be carefully watched to prevent excessive wear from damaging rotating elements. Money spent for such inspecting comes under "preventative" maintenance, and is fully justified. It is therefore necessary that an organization for making such inspections be set up under the maintenance department. These inspectors must be charged with the regular inspection of all equipment, such inspections to be duly reported on forms provided for the purpose.

All types of equipment do not require the same kind of inspection. Mining machines, locomotives, and some few classes of stationary equipment such as pumps in important locations, and tipple equipment, must be inspected after each operating shift. The inspector should open motor, control, fuse, and other important compartments and see that all parts are functioning properly and in good order before the compartment is closed.

Such equipment as substations, fans, local distribution lines, field pumps, etc., should receive a thorough inspection once

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Care and Recovery of Supplies Underground

By H. A. Treadwell*

IN THIS SUBJECT, "Care and Recovery of Supplies Underground," I will attempt only to show how one can so manage in the use of their major supplies as to make a considerable reduction in underground expenses.

In the average coal mine the timber cost is a significant item of the underground material expense. This cost can usually be reduced if care is exercised in the method of distribution of timber to the various working places.

In some mines the crew on the gathering locomotives have sufficient time to deliver the timbers to the working places. Where it is possible to do this, it is generally found to be advantageous to have a material yard inby the parting where the motor delivers the coal and receives the empties.

In this material yard is stored all the different sizes of timber, rail, and ties. Whenever timber is needed at the face the loaders pass this information on to the motorman, and the motor crew load the material onto the next empty going to that place. There is never any surplus of timber to be left in the gob. The timber of right length is delivered at the right place, where and when it is needed.

The storing of track material in this material yard will greatly reduce its loss, for often under the old method it was left where last used, only to be looked up when needed at some new place. Only too well we know the results of this haphazard method. The material is lost or covered by a fall and new material is ordered from the top, thereby resulting in an inevitable additional cost to our materials.

In large mines where the haulage is fast and the slightest delay to a motor crew means a loss in tonnage, it is impossible to deliver timber with the gathering motor crew.

In such mines the foreman in charge of a section should order only the amount of timber sufficient for his immediate needs, and he should make a concise, detailed list showing the correct number, size, and length of pieces, and the exact location to where the material is to be delivered. The night foreman should see that these instructions are carried out. A large number of mine managers will say it can not be done, but it is possible to deliver timber in the right quantity where it is needed. If you are going to successfully reduce the underground cost of material and supplies, it is necessary to eliminate the loss through careless distribution, which carelessness allows so much material to be covered up in the gob or left at places where it is not needed.

Of course, there can be a large saving made in the pulling and reusing of timber. To do this successfully heavy tapered cap pieces should be used and especially trained men should be employed on this kind of work. The recovery of timber is a topic in itself, and while it is very interesting and generally affords a saving where possible to use it, it is not in use in the average coal mine. It is generally used today more as a factor of roof control in special methods of mining rather than for the saving made through the reuse of the timber.

Another possible factor of saving is in the handling of track material. I wonder if any of you men have ever figured out what becomes of all the fishplates that are sent into a mine. I have often felt that there is an unwritten law among tracklayers that fishplates can be used but once and then must be thrown into the gob. Where do they go? I do not know, but I can tell you how to partially stop them from disappearing. Make it a hard and fast rule that these fishplates should always be fastened together and connected to a rail wherever possible. If they are fastened together and the roadway in entries and rooms are kept fairly clean, you will thereby reduce this loss.

How often have you seen track spikes and bolts in old powder boxes and in piles along the entry, and even in old rooms? You have seen them as often as I have, and why? Because the men either did not have a bucket in which to carry them, or were too lazy to use that bucket. Track fastenings cost a considerable amount of money; roughly speaking, $2,000 a minimum carload; and you can not afford to waste them. If these are allowed to be scattered about promiscuously they may finally wind up in a carload of steam coal being shipped for use in automatic stokers. If so, you will probably lose a customer, and one can't afford a loss through carelessness of such sort.

Therefore, I would recommend that you have a material shanty in each section in which you store your switch throws, bridles, fishplates, bolts and spokes, and don't permit them to be left kicking around the entries. Furnish your tracklayer with small buckets in which to carry spikes and bolts, and see that he uses them. Always furnish him with a good spike bar and a wrench so that he can recover some of the spikes and bolts. The only new equipment that is necessary to put the above into effect is a couple of small buckets, and I can assure you this expenditure will prove profitable.

A third factor of possible saving is in the use of trolley and wire material. Everyone realizes that to get good service and long life out of trolley lines, the wire must be well stretched, fairly level and straight.

In order to maintain a level trolley the wires should be hung at a varying distance from the roof. To overcome the variable height of the roof, do you use additional bells on the hangar to make the necessary extension? Some do, and this is an expensive method. I have often observed $10 worth of bells on one hangar where the use of 15 cents' worth of 1¼-in. pipe would have proved to be more satisfactory. A single bell is all that is needed on any hangar.

Have you ever heard coming down the entry a couple of men clanking and moving along like a couple of pack mules? I have, and they generally were wire men carrying wire stretchers, a box with bells, a few bolts, tools, and other necessary supplies. Then you have probably seen them hunting around in a crosscut, kicking up the dirt, or looking behind timbers, hunting for some hangars they have cashed at some other time. Did you ever watch the road cleanings dumped? If so, you have seen bells, clamps, expansion bolts, and every kind of wire material in it. You will reduce this loss by the use of a wire truck.

Where it is possible to use a wire truck this method is much simpler and less expensive. This truck is fitted with all the different material needed for wire work. Then the main underground supply can be kept at one place around the bottom, and there is no need for the wire crew to cash surplus material all over the mine, one-half of which is never found or used. The section foreman should keep only a very limited supply of wire material in his material shanty for emergency repairs. By the use of this wire truck you will prevent the leaving of supplies scattered around the mine to be lost in the gob.

In the last few years we have watched the growth of mechanical loading. One of the main problems in mechanical loading is the handling of repair parts, supplies, and oiling. It is a problem to have the repair parts at the right place, at the right time, and not to carry an excess of repairs in stock.

One company solved this problem to a certain degree by the following method: They work on an average of five loading machines on a territory or cross entry. Of course, they have the required number of cutting machines, drills, and haulage motors here, and this section is a small mine in itself.

Centrally located in this territory is a repairman's shanty, and the repairman stationed here keeps a small amount of the most used repair parts. Now, when a breakdown occurs, he makes the necessary repairs, and then immediately calls the main shop on the bottom for a replacement of the parts used on this piece of work. These parts are sent to him on the next main line motor trip to the section.

In the shop on the bottom a general supply of repair parts are carried. This supply, although limited, covers the list of usual parts that break and cause de-

(*Continued on page 71*)

* General Superintendent, Chicago, Wilmington & Franklin Coal Co.

Problems in Coal Mine Power Distribution

By F. E. Gleason*

ELECTRIFICATION and coal mine mechanization are so closely allied in most coal mines that to discuss one necessarily means a discussion of both.

The development, progress, and success of mechanization is largely dependent upon a safe and adequate electric service underground.

The problems of electrification at the mines of the United States Fuel Company, while many and varied, are probably very similar to those experienced by many operators throughout this country. For this reason we will discuss only a few points which have been of most interest to us.

Electric power is purchased from a public utility corporation which serves all coal mines in the Carbon-Emery coal fields of Utah.

Power is delivered to the central substation of the United States Fuel Company at 44,000 volts, where it is metered and stepped down to 11,000 volts for distribution to the mines and tipples. Outdoor substation transformers at the tipples step the voltage down from 11,000 volts to 440 volts. All current used at the tipples is 440 volts alternating current.

The outdoor mine substation transformers step the voltage down from 11,000 to 2,300 for motor generator sets, fans, etc., located near the mine portals.

Two thousand three hundred volt power is transmitted by three conductor armored cable direct to underground motor generator sets. This cable is placed in trenches either along main haulageways or in return air courses. Care is taken to cover cable sufficiently to prevent any possibility of damage due to derailments or falls from roof or rib.

Where convenient, it has been found economical to tap the 2,300-volt underground cable for small semiportable transformer stations supplying power to the larger dewatering pump units.

These small transformer stations are built of sheet steel on a channel and angle-iron frame, using No. 3 gauge sheet for the bottoms, No. 16 gauge for sides and tops; doors and ventilators are No. 8 gauge. The bottoms are made tight and filled with dry sand for a depth of 8 in. to absorb oil leakage in case of transformer trouble. Ventilating doors are held open by an inflammable cord and arranged to close by gravity if cord should be burned by fire within the housing. Primary and secondary circuits are protected by overload circuit breakers. Transformers and housing are thoroughly grounded.

The underground motor generator units are housed in concrete rooms located in crosscuts between main and return air courses to facilitate the ventilation.

All underground equipment other than mentioned is operated by 250 volts direct current.

As the coal seam is from 7 to 30 ft. thick, and comparatively level, the problems of underground wiring are simple.

The underground wiring is standardized as far as possible to simplify the construction and minimize the number and quantity of parts necessary to be carried in stock.

Trolley wires are supported 6 ft. 6 in. above top of rail. Where the roof is under 9 ft. in height, hangers with pipe extensions are used. Where higher roof is encountered, 5/16-in. steel messenger span wire construction is standard.

Machine line extensions and shooting lines are attached to roof where roof is over 7 ft. 6 in. from rail.

All shots are fired by momentarily energizing an independent shooting circuit after all men have been checked out of the mine. Shooting circuits are placed in back entries or on side of entry farthest removed from exposed power lines. Locked switches are placed on all branch lines to entries or districts and also where shooting lines cross power lines.

Methods of supporting wiring and examples of mine standard instruction prints are shown on Figs. 1, 2, and 3.

Considerable study has been made of the peak power load demand with a view of reducing the power cost without materially affecting production.

Power is purchased on the following schedule:

Demand.—A flat rate per month per maximum horsepower for any five-minute peak demand period with a 100 kw.-hr. energy allowance for each horsepower.

The energy charge is on a sliding scale with a maximum rate for 100,000 kw.-hr. or less and a minimum rate for all over 10,000,000 kw.-hr.

Discounts.—Fifteen percent monthly bill where load factor is 50 percent and less than 60 percent, with an increase of 1 percent discount for each 10 percent increase in load factor. Load factor being the ratio of the average demand to the peak demand.

It is easily seen that the greatest saving can be made by reducing the peak demand, as this would not only reduce the demand charge but also increase the load factor.

Each horsepower reduction in demand means a saving of $2 or more in power cost.

Our demand power load can be divided into three distinct divisions:

1. Uniform demand.—Ventilating fans, tipples, pumps, etc.
2. Slightly variable demand. — Coal cutters, drills, mechanical loaders, and gathering motors.
3. Highly fluctuating demand.—Main haulage and hoists.

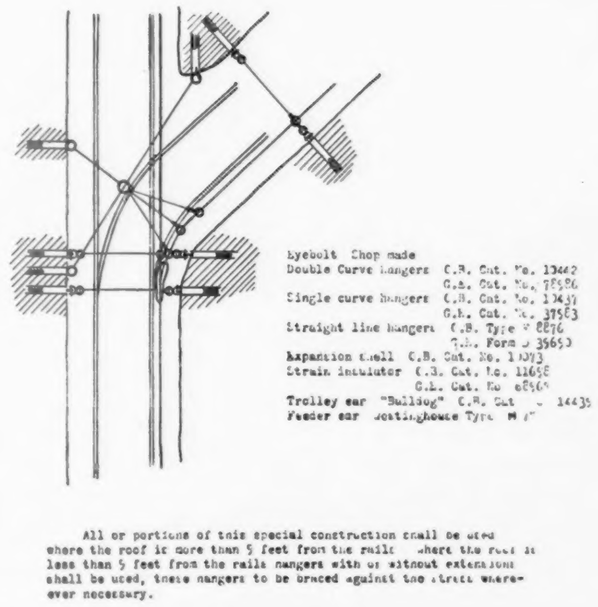

Fig. 1

* General master mechanic, United States Fuel Company.

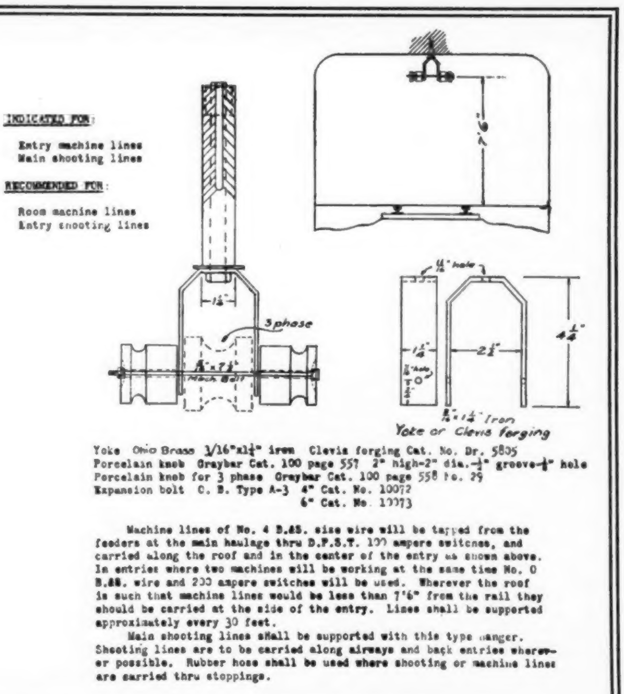

Fig. 2

A reduction in the power requirements of equipment listed in the first division can be only through the proper loading of motors to give the maximum efficiency.

The greater portion of the power demand for equipment included in the second division is materially divided into districts; i. e., each district will comprise a mechanical loading unit composed of the following equipment: One cutting and drilling machine, one loading machine, and a gathering motor. The average power demand in each district is approximately 100 hp.

A reduction in power demand in a loading district could be made by operating the cutting and loading machines on different shifts, which in most cases would not be economical, because of the additional overhead expense.

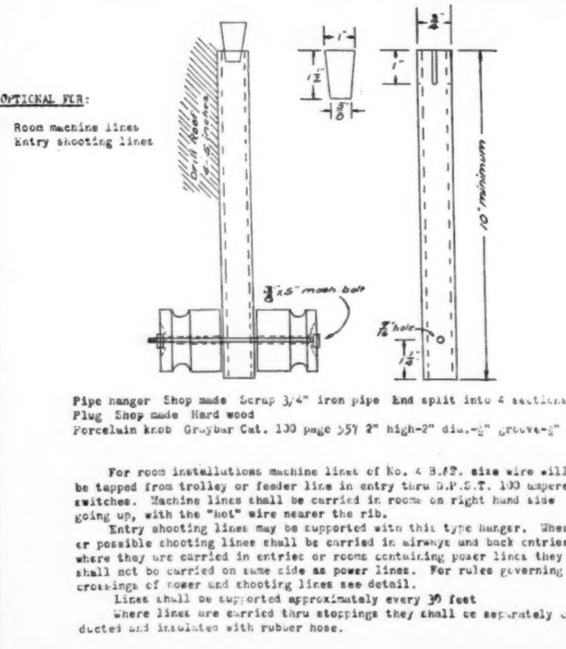

Fig. 3

It is to the highly fluctuating demand we have devoted the most study. Since power peaks created by main haulage motors and hoists are only excessive when their demand is coincident (see Fig. 4) it would seem that a system of dispatching, or block signals controlling their movement would prove a solution. The fact that the different mines are a considerable distance apart and excessive peaks may be caused by coincident haulage demands between mines makes such a system impractical.

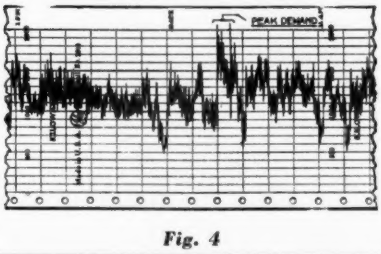

Fig. 4

Gravity tramways are used to lower the coal from the mine to the tipple a distance of from 6,000 to 10,000 ft. with a drop of 800 ft. Electrically driven balanced incline plane hoists handle trips of approximately 100 tons on these tramways. One hoist is now equipped with regenerative breaking (Fig. 5).

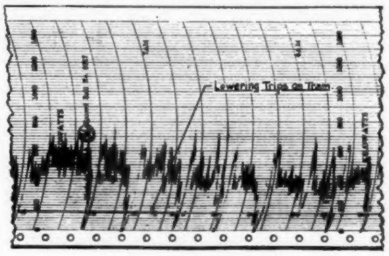

Fig. 5

What we propose doing to eliminate excessive power peak demand, caused by haulage and hoists, is to automatically cut the power from one or more of the mechanical loading districts. As soon as the peak is relieved the power will be automatically restored. No interruption will last longer than four minutes. The control system will be entirely automatic in its operation and so arranged to take advantage of the diversity of peak power demands between the mines and only cause outages in the mechanical loading districts of that mine which is the greatest offender in creating the excessive peak demand. A study of the recording wattmeter charts shows that an outage of one-half of 1 percent of the total loading time of the mechanical units will result in a saving in excess of 10 percent in total power cost.

Not only have the methods of mining been revolutionized by mechanization but the haphazard methods of the mine electrician are a thing of the past. Competent mine electricians with some understanding of the technical side of electricity are a prerequisite to the successful electrification of any mine. They must be able to test the electric equipment in their charge and properly interpret the result.

As an example, at one of our mines the Joy coal-loading machines were having frequent armature failures; at an

(*Continued on page 71*)

Automatic Pump Control

By Chas. H. Matthews*

Discussion by James Hyslop†

AUTOMATIC control of centrifugal mine pumps has proven more economical and reliable than hand-operated equipment. When trouble occurs on an automatically controlled pumping unit it shuts down, locks out of service, and sounds an alarm.

Experience has shown that a simple control scheme must be employed even though the first cost may be higher than a lower cost complicated control.

In general, the control equipment necessary for automatic operation consists of an oil circuit breaker panel having overload trip, automatic pump motor starter, priming pump, auxiliary control panel and accessories.

The oil circuit breaker panel provides overload protection to the complete pumping unit. This panel also mounts any instruments, such as indicating or curve-drawing ammeters or time-recording electric clock. Recording ammeters having a paper speed of 1 in. per hour provide a definite record of the operation of the pumping unit. An electric clock is an inexpensive instrument which will register hours the pump is in operation.

The automatic starter for the main pump motor should have definite time acceleration and of such design that all parts can be mounted in restricted spaces.

Priming pumps normally used are 50 and 100 cu. ft., depending upon the size of pump and area of the suction line. These pumps are motor driven by either silent chain or flexible rubber belts. An automatic enclosed priming pump motor starter is controlled by the auxiliary control panel. A vacuum breaker with control switch forms a part of the priming equipment.

The auxiliary control panel contains two or three controlling contactor relays, a timing relay, and control switch, together with alarm equipment. This panel occupies but little floor space and should, where possible, be mounted near the priming pump and vacuum breaker in order to conserve wiring.

Accessories include sump float switch, priming valves either solenoid or spring operated, flow switch on check valve or pressure switch on pump casing, and control transformers.

Simplified control results in arranging each pump as a separate and distinct automatically controlled unit entirely independent of the automatic control of other pumps. No interconnection between the control of several pumps in a station is necessary except to change the sequence of operation. The setting of the sump switches determines when each pump starts and stops. During low water probably one pump in a station would handle the water, with a second pump operating occasionally for short periods.

Change in sequence of operation can be governed by changing the settings of the sump switches. This is not always convenient or possible, so a sequence panel has been developed. A sequence panel is needed for each pump, or rather for each sump switch. The sequence panel for the "pilot" sump switch, which is the first switch to close on high water in the sump, contains a plug receptacle and a plug with flexible cable. All other sequence panels have the plug and receptacle, but also have a single pole contactor and a timing relay. The plug receptacles are connected to the auxiliary control panels of the various pumps while the plugs are connected to the sump switches. All sump switches are set at different control levels in the sump so by transferring the float switches between the different sequence panels any time of operation of the pumps can be obtained. The "pilot" sequence panel permits the "pilot" pump to start to prime as soon as power has returned after a power interruption. The other pumps are primed and started whenever the timing relay trips on the sequence panel. This arrangement prevents all pumps from starting at once after a power failure, and allows a change in sequence of operation of the different pumps in a station.

Where the sump is driven in the coal seam on a slope there is seldom sufficient height for proper operation of the sump switch. For such conditions a submerged float equipped with a mercury switch has been developed. This switch, together with a 2-pole relay added to the usual control equipment, permits lowering the water in the sump to the limit of suction lift of the centrifugal pump.

The motor and pump bearings are equipped with thermostats so the pump will be shut down before bearings become overheated. Present designs of pumps are provided with either roller or ball thrust bearings. While these bearings when properly oiled seldom fail, they should have thermal protection. Several makes of bearing thermostats have been tried, but none seem to have the proper performance to protect roller or ball bearings. The failure of thermostatic relays to protect roller or ball thrust bearings is probably due to the destruction of the rollers or balls before the heat is transmitted to the raceway where the relay is mounted.

Pressure switches mounted on the pump casing will shut down the pump if it loses its water in the suction stages. A flow switch on the check valve will protect the pump from loss of water the same as a pressure switch. A flow switch is an especially desirable accessory when filling an empty column line, as this switch remains closed and keeps the pump in operation, whereas a pressure switch may not remain closed on account of insufficient pressure.

Priming valves (spring operated preferred) are mounted on the suction stage of the centrifugal pump. Where the pump consists of two multi-stage units connected by a series pipe it is often desirable to equip the high-pressure unit with a ball priming valve. This valve closes as soon as water from the series pipe rises in the pump casing, thus permitting priming to continue until the low-pressure unit has been properly primed.

All pumps should operate frequently to keep the electrical equipment dried out and in condition to perform when needed. When a pump stands idle any length of time the packing becomes dry and permits air to enter the casing so it will not prime. When this occurs it may require some time to get the pump primed and started. Several attempts to prime may occur before the pump is locked out and another pump is started. After each attempt to prime the pump must come to rest, as a false start may result in damage to the improperly primed pump.

Usually a plunger pump will prime itself without a serious delay, but pumps having a large valve chamber in proportion to the size of plunger are not easily primed.

Priming equipment similar to that used for centrifugal pumps can be installed, but the expense may not always be warranted.

An inexpensive scheme of control has been developed which has proven reliable over several years operation.

This control requires a foot valve on the suction pipe. A small magnet valve normally closed is connected between the column line and suction valve chamber of the pump. An overflow pipe is connected to the suction chamber and the other end submerged in the sump. A pressure switch connected to the discharge column line has contacts normally open on pressure head and contacts closed at half pressure. The sump switch opens the magnet valve which allows water to flow from the discharge column line into the valve chambers and suction pipe. When the water has drained from the discharge column to a pressure lower than normal head, the pressure switch closes its contacts and starts the pump motor. When the pump motor starts a contact on the starter bridges the pressure switch, which can then open as pressure is built up in the discharge line. A control relay closes as the pump motor starts, which deenergizes and closes the magnet valve.

Barrett-Haentjens & Co., Hazleton, Pa., originated the idea of automatically controlled centrifugal pumps. Their priming pumps have the cylinder or cylinders mounted vertically. The vacuum breaker is equipped with 2-pole switch, which opens after the main pump is put

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† Walter Bledsoe & Co.

in operation and the vacuum breaker drains. Sump switches must be 2-pole for complete operation and protection of the equipment.

Goyne Steam Pump Co., Ashland, Pa., has developed priming pumps having horizontally mounted cylinders. A single-pole sump switch and a single-pole vacuum breaker switch provide proper protection. Their scheme of control requires the priming pump to continue in operation until the centrifugal pump has built up its pressure. An impulse pressure switch on the pump casing stops the priming pump and connects atmospheric pressure to the vacuum breaker so it drains almost instantly. This switch also connects in circuit a pressure diaphragm which holds the vacuum breaker switch closed. The vacuum breaker switch thus remains closed and keeps the centrifugal pump in operation. Any loss of pressure opens the vacuum breaker switch and shuts down the pump.

Both designs of equipment have proven entirely satisfactory and can be arranged to work with any scheme of control that may be assembled by engineers making the installation.

Barrett-Haentjens & Co., automatic control for centrifugal pumps; operation:

1. Knife switch "CS" is closed by hand. This switch normally connects the float switch "FS" in circuit.

2. At a predetermined level of water in the sump, float switch (FS-1 and FS-2) closes.

3. Closing of FS-2 energizes "MC" relay and closes relay contact No. 1 which is in series with BT, CR-1C, PR, FS-1, CS-1, and CR-1.

4. Closing of FS-2 energizes CR-2, thus closing contact CR2A, which is in series with VB-1, FS-1, CS-1, and CR-1.

5. The timing operation of "MC" relay starts as soon as FS-2 closes. Relay "MC" must have timing set so contact No. 4 will not close until after the centrifugal pump is primed and in operation.

6. Closing of FS-2 starts the priming pump as CR-1B is normally closed.

7. The priming pump exhausts the air from the centrifugal pump casing through priming valve.

8. When the air in the centrifugal pump casing is sufficiently rarefied, water enters through the suction piping into the pump casing, filling same, and rises in the vacuum breaker float chamber. The water rising in float chamber raises the copper float, which closes vacuum breaker switch VB-1 and VB-2.

9. Closing of VB-1 energizes CR-1 as FS-1 and CR-2A are closed as above mentioned.

10. Closing of CR-1 opens CR-1A in the "alarm" circuit and opens CR-1B, which stops the priming pump.

11. CR-1D is closed, which acts as a push button to start the main centrifugal pump motor. The centrifugal pump comes up to speed, builds up pressure, and closes "PR" and as CR-1C and CR-1D are closed together the running circuit is established through CS-2, FS-2, BT, MC relay contact No. 1, CR-1C, PR, FS-1, CS-1, and CR-1.

12. The centrifugal pump has now been primed and is in normal operation, and the priming pump has been shut down as CR-1B is opened when magnet CR-1 is energized.

13. The "alarm" circuit is open as CR-1A is open even after relay contact No. 4 closes.

14. Vacuum breaker has drained and opened VB-1 and VB-2.

15. Opening of VB-1 takes shunt circuit from around PR, BT, and CR-1C so the centrifugal pump is protected against loss of pressure.

16. During the entire time the centrifugal pump is being primed and put in operation, "MC" relay operates, and after a definite time trips and closes contact No. 4, but as CR-1A is open the "alarm" can not sound. Tripping of "MC" relay also opens contact No. 6, thus locking out the priming pump starter.

17. CR-2 is used for connection in series with VB-1, so if the vacuum breaker fails to drain and open VB-1, CR-2 will open the circuit as soon as "MC" relay trips and opens contact No. 6.

18. The centrifugal pump continues in operation until the water has been lowered in the sump a sufficient amount to open float switch FS-1 and FS-2. The opening of FS-2 resets "MC" relay and opens all control circuits, thus shutting down the centrifugal pump.

19. VB-2 is used to prevent "MC" relay from resetting if the vacuum breaker fails to drain even though FS-2 opens. The opening of FS-1 shuts down the centrifugal pump and when CR-1 opens CR-1A closes, and the "alarm" will sound if VB-2 sticks closed.

20. Overheated bearings causes the switch of bearing thermostats "BT" to open the control circuit, shut down the centrifugal pump, and lock out the equipment. Bearing thermostats have to be reset by hand so that the pump will not automatically restart until some one visits the installation and locates the trouble. It is, of course, assumed that the overheated bearing will be repaired before attempting to restart the equipment. The "alarm" will not sound a warning when bearings overheat, as bearing thermostats "BT" must be connected in the control circuit to completely lock out the entire equipment.

21. An "alarm" can be connected to a second float switch to give a warning when the water in the sump reaches a dangerous height.

22. As mentioned before, float switch "FS-2" energizes "MC" relay and the priming pump starts to prime the centrifugal pump. If the centrifugal pump fails to prime within the time setting of "MC" relay, this relay will trip, thus closing relay contact No. 4, which stops the priming pump, locks out the equipment, and sounds the "alarm," since CR-1B is closed. If power is interrupted during the time the pump is shut down due to failure to prime as just mentioned, "MC" relay will be reset, and upon return of power the priming cycle will be repeated.

23. If the centrifugal pump loses its water when in operation, due to a leak in the packing glands or suction line, or if the float switch fails to open at low-water setting, the pump pressure will be reduced and "PR" will open and shut down the centrifugal pump. Opening of "PR" closes CR-1B, which sounds the "alarm."

Each centrifugal pump should have its own priming pump with control independent of other pumps in a station.

Float switches, one for each pump, should all be set for different levels of water in the sump. The operation of each centrifugal pump is therefore governed by the setting of its float switch.

The only interlocking required between pumps in a station is change in sequence of operation, and to prevent all pumps from starting at once when power returns after an interruption when all float switches are closed.

Change of sequence of operation will be accomplished by interchanging float switches from one pump to another. This will be accomplished by 2 2-pole plugs attached to the float switches with the plug sockets wired to each pump auxiliary control panel.

One float switch—without timing relay—will be set for the pilot control so that the pump to which this float switch is plugged will start first and continue to run after all other pumps have shut down and the pilot pump has lowered the sump until its float switch opens.

All other float switches will have a timing relay with single-pole contactor. Each of these float switches to be set for different levels of water in the sump and all to close at different higher water levels than the pilot float switch.

The timing relays must all have different time settings to delay starting each pump.

When power is applied the timing relays operate and trip to close the single-pole contactor and remain in this position until a power failure occurs.

After the return of power the pilot pump will prime and start, and if other float switches are closed the pump or pumps to which they are connected will start to prime in sequence at different times after the pilot pump has primed and started, depending upon the time setting of the relay. This will prevent all pumps from starting at once when power returns after an interruption.

If the pilot pump fails to prime and start, the water will continue to rise in the sump until the next float switch closes and the pump to which it is plugged will start.

Drg. 66-321 shows sequence panel assembly and wiring of plugs and relays.

"Goyne" Automatic Control for Centrifugal Pumps

Operation:

1. Knife switch "CS" is closed by hand. This switch normally connects the float switch "FS" in circuit.

2. At a predetermined level of water in the sump, float switch "FS" closes.

3. Closing of float switch "FS" energizes MC-11 relay, thus closing contact No. 1, which is in series with bearing thermostats "BT," relay coil "CC," relay contact "DD-1," and float chamber switch "H."

4. The timing operation of MC-11 relay starts as soon as float switch "FS" closes. Relay must have timing set so contact No. 4 will not close until after the centrifugal pump is primed and in operation.

5. As impulse valve switch "B-1" is always closed when the centrifugal pump is not in operation, the closing of float switch "FS" energizes the priming pump motor starter "PP" and the priming pump is put in operation.

6. The priming pump exhausts air from the centrifugal pump through priming valves located at high points on the centrifugal pump casing, and into priming line "E" passing into balanced float chamber "F" and through balanced valve of same into line "G" communicating with vacuum pump which exhausts the air to the atmosphere.

7. When the air in the centrifugal pump casing is sufficiently rarefied, water enters through the suction piping into the pump casing, filling same and then taking the same course as the air, as outlined above, until said water reaches float chamber "F." The water rises in float chamber "F" and raises the copper float until balance valve cuts off all communication to the priming pump.

8. The copper float in the float chamber when in its fully raised position causes switch "H" to close, which completes the circuit through the magnet coil of relay "CC." The closing of contact "CC-1" acts as a push button to the main motor starter, and the centrifugal pump is brought up to speed.

9. The impulse of water in the first stages of the centrifugal pump reacts upon the priming or impulse valves, which in its raised position automatically cuts off communication of the water in the centrifugal pump from the priming system, opens switch "B-1," which shuts down the priming pump and admits atmospheric pressure to the priming system, thus draining through drain valve "I" the water which had been previously drawn by vacuum into float chamber "F."

10. Pressure generated in the first stages of the centrifugal pump is transmitted through pressure line "J" to pressure locking device "K," which rises and maintains control switch "H" in closed or running position and the centrifugal pump continues in normal operation.

11. During the entire time the centrifugal pump is being primed and put in operation MC-11 relay operates, and after a definite time trips and closes contact No. 4. If the centrifugal pump is primed and put in operation contact "B-2" of the impulse valve will be open and the "alarm" can not sound. Since contact "B-2" will be open, the magnet of relay "DD" will not be energized and contact "DD-1" will remain closed so the centrifugal pump can continue in operation.

12. The centrifugal pump continues in operation until the water has been lowered in the sump a sufficient amount to open float switch "FS." The opening of float switch "FS" resets the MC-11 relay and opens all control circuits, thus shutting down the centrifugal pump.

13. Overheated bearings cause the switches of bearing thermostats "BT" to open the control circuit and shut down the centrifugal pump. When the pump shuts down contact "B-2" of the impulse valve will close and as the MC-11 relay will be in the tripped position the "alarm" will sound. Bearing thermostats have to be reset by hand so the pump will not automatically restart until some one visits the installation to make an inspection and correct the trouble.

14. If the centrifugal pump primes successfully and starts but fails to build up sufficient pressure to raise the impulse valve switches "B-1" and "B-2," the priming pump will continue to run until the MC-11 relay trips and closes contact No. 4. Tripping of the MC-11 relay shuts down the priming pump. Closing of contact No. 4 sounds the "alarm," energizes the coil of relay "DD," and opens contact "DD-1," which shuts down the centrifugal pump.

15. If the centrifugal pump fails to prime within the time setting of the MC-11 relay, this relay will trip and close contact No. 4 and as contact "B-2" of the impulse valve has not opened, the "alarm" will sound. Tripping of the MC-11 relay shuts down the priming pump.

16. If power is interrupted during the time the pump is shut down due to failure to prime as just mentioned, the MC-11 relay will be reset and upon return of power the priming cycle will be repeated.

17. If the centrifugal pump loses its water when in operation, due to a leak in the packing glands or suction line, or if the float switch "FS" fails to open at low-water setting, the pump pressure will be reduced, which will cause locking device "K" to drop so that switch "H" opens and shuts down the centrifugal pump. As contact "B-1" of the impulse valve closes the priming pump will start and run until it either primes and the centrifugal pump starts or the MC-11 relay will operate until it trips and closes contact No. 4, thus sounding the "alarm" and locking out the entire equipment.

Each centrifugal pump should have its own priming pump with control independent of other pumps in a station.

Float switches, one for each pump, should all be set for different levels of water in the sump. The operation of each centrifugal pump is therefore governed by the setting of its float switch.

The only interlocking required between pumps in a station is change in sequence of operation and to prevent all pumps from starting at once when power returns after an interruption when all float switches are closed.

Change of sequence of operation will be accomplished by interchanging float switches from one pump to another. This will be accomplished by 2-pole plugs attached to the float switches with the plug sockets wired to each pump auxiliary control panel.

One float switch—without timing relay—will be set for the pilot control so that the pump to which this float switch is plugged will start first and continue to run after all other pumps have shut down and the pilot pump has lowered the sump until its float switch opens.

All other float switches will have a timing relay with single-pole contactor. Each of these float switches to be set for different levels of water in the sump and all to close at different higher water levels than the pilot float switch.

The timing relays must all have different time settings to delay starting each pump.

When power is applied the timing relays operate and trip to close the single-pole contactor and remain in this position until a power failure occurs.

After the return of power the pilot pump will prime and start, and if other float switches are closed the pump or pumps to which they are connected will start to prime in sequence at different times after the pilot pump has primed and started, depending upon the time setting of the relay. This will prevent all pumps from starting at once when power returns after an interruption.

If the pilot pump fails to prime and start, the water will continue to rise in the sump until the next float switch closes and the pump to which it is plugged will start.

JAMES HYSLOP—*Walter Bledsoe & Co.*

THE Dresser mine is situated on the west bank of the Wabash River, near Terre Haute, Ind. This location might suggest that here is one place where coal mining should be a romantic business, but a few years experience trying to rob the black diamond from under the banks of the Wabash convinces one that Paul Dresser was thinking of something other than a coal mine when he composed his famous song.

One of the biggest problems at the Dresser mine has been that of handling the water which runs into the mine from the gravel bed above. The coal lies 225 ft. below the surface, the amount of solid strata over the seam varies from 200 ft. to much less than this, the remainder of the overburden being sand and gravel, an inexhaustible source of water which is tapped whenever the roof is broken by a major cave-in. These breaks of water vary from negligible amounts to as high as 1,000 g. p. m.

It is impossible to anticipate where or when a flood is going to occur, therefore we have found it necessary to have a lot of special emergency equipment always available to take care of these contingencies. During the early life of the mine we were mining under a heavy rock overburden and experienced very little trouble from water. We were then able to handle our drainage problems with a few small reciprocating pumps. As water began to give more serious trouble we found it necessary to use centrifugal pumps to obtain greater capacity and higher efficiency. In handling large volumes of water, and where it must be pumped from the mine under considerable head, the power cost becomes a matter of primary importance. At the Dresser mine we are pumping the water out of the mine under a head of 250 ft., and the quantities are such that only by the application of special equipment and methods have we been able to keep the cost of drainage within reasonable limits, and to safeguard the property. In our experience we have adopted some methods that might be of general interest, and I have sought to describe briefly a few of these below.

As mentioned above, one of our problems is that it is impossible to anticipate when or where one of these breaks of water is going to occur. It would be impractical to have pipe lines laid and pumps set promiscuously all over the mine, ready to handle possible floods. It is also imperative that the water be taken care of before it has time to spread over a wide area and soften the fireclay bottom, bringing on a squeeze.

To meet these difficulties the desirability of portable pumping equipment was clearly evident. Therefore, we have gone a considerable length in building portable pumps, in capacities ranging from 150 to 1,000 g. p. m. and from 25 to 100 hp. We had successfully applied the idea of portability in other lines before this, one interesting application being that of a complete synchronous converter substation built on wheels and only 38 in. in height. Our coal seam is only 48 in. high, and in order to clear overhanging

boulders we must keep all our equipment under 38 inches. In designing these pumping outfits we had to keep this factor in mind. To mount the motor and pump together on a base and then simply place the complete unit on a flat-top truck was out of the question, as the height of such an arrangement would be prohibitive.

We overcame this feature by building the pump bases of arc-welded structural steel, made rigid enough to withstand tendencies to distortion, and then fastening the wheels and axles directly to this base. We were thus able to build centrifugal units as large as 100 hp. as easily portable as a mine car, and low enough to travel anywhere in the mine. The electrical control apparatus is all mounted on the truck, wired complete, and all that is necessary to start the outfit is to tap the trolley wire or feeder line. Each unit is equipped with pressure gauges and pressure relays to protect the pump in case of running dry. Another advantage in constructing the pump bases of steel is the fact that they are much more rugged than the conventional cast-iron type and more able to withstand the severe usage sure to be encountered underground.

Another feature in the construction of these units, especially in the smaller sizes, is their flexibility to suit the various conditions under which they must operate. All pumps are of the same maximum head; namely, 250 ft. This permits of their being used to pump to the surface through a bore hole when necessary. However, they are frequently called upon to simply pump the water from one location in the mine to another, as when pumping from a water break to a bore-hole pump. The amount of water thus to be handled varies to a great extent, and if it is much below the capacity of the pump, poor efficiency is realized, as the pump must be throttled to reduce its capacity. To meet this condition we constructed one unit with a speed-regulating rheostat. This gave better satisfaction than the constant speed units, as the head and capacity could thus be controlled. On a later unit a still more satisfactory scheme was adopted which greatly improved the efficiency and flexibility.

In this later design two pumps were used instead of one. These two pumps were mounted in tandem and connected together and to the 25-hp. motor by flexible couplings. Each of the pumps are rated at 150 g. p. m., 125-ft. head at 1,800 r. p. m. By a system of valves and piping the following conditions can be met: By disconnecting one coupling, pump No. 1 can be operated alone, giving a capacity of 150 g. p. m. at 125-ft. head. By running both pumps and setting the valves for series operation 150 g. p. m. at 250-ft. head can be obtained. By setting the valves for parallel operation 300 g. p. m. at 125-ft. head can be developed. Any of these changes can be made in a few minutes, and maximum efficiency is obtained in each case. This makes a highly satisfactory arrangement.

Our experience with portable centrifugal pumps has been so satisfactory that we are convinced that it is good practice to mount all pumps to be used underground in this manner. The construction cost is not a great deal more than that of pouring a concrete base and making a permanent setup in the mine, and the units can be constructed in the machine shop by skilled mechanics and permanent alignment assured. Then there are the desirable features of quick set-up and the ease with which the pump can be transferred from one location to another or taken out for repairs.

Portable pumps would be useless without the necessary pipe lines to carry the water. Sometimes the water is hundreds of feet from a pipe line, and the time it would take to lay an iron pipe line would allow the water to spread over a considerable area. We have met this problem by having 1,000 ft. of 2½-in. fire hose in 50-ft. lengths always available. The 50-ft. rolls can be piled in a mine car and by the time the pump is located and ready to operate the hose can be strung out and ready for service. It would be difficult to exaggerate the utility of this hose, as there are many other uses to which it is put. Suction hose is used for flexibility and portability on all pumps. We have found it desirable to use a 15-ft. length of 6-in. high-pressure hose on the discharge side of even our 100-hp. pumps to facilitate setting up in a hurry and to protect the pump from strains due to misalignment of the pipe line.

We have always followed the practice of sealing off our old territory as soon as it is worked out. This is a comparatively simple matter where no water is to be confined. Where water is a problem, one of two methods must be followed; namely, keep the water drained from behind the seal or build bulkheads strong enough to withstand the water pressure. In the first case, the cost of pumping the water is a most undesirable feature, and if this can be eliminated by special bulkheads the additional cost of the latter method will prove a good investment.

On one occasion we were faced with the problem of sealing off a territory which was making 600 g. p. m. and it was costing us $60 per day to handle this water. There were four entries in parallel (12 ft. wide), all of which had to be sealed. These bulkheads were built 4 ft. in thickness, of reinforced concrete and brick. A hitching 4 ft. deep was cut in either rib, and the fireclay was removed down to solid rock in the bottom to a depth of about 3 ft. After this wall was completed a concrete arch, 10 ft. in length and 12 in. thick, was placed in front, and the bottom was floored with 12 in. of concrete for the same distance. To seal the space left over the wall and arch by the shrinkage in setting, a number of 2-in. pipes were placed through the concrete, and after setting for a few days cement and sand under pressure was forced through these pipes to close up these leaks. We built a special cement gun operated by water pressure to handle this part of the job. We were able to apply a pressure of 120 lbs. per sq. in. with this outfit. Through one of these seals we placed two 8-in. pipes and, while the concrete was setting, we pumped the water from behind them to keep the pressure down.

After we considered that sufficient time had been given we closed the valves on the seals and allowed the pressure to build up. In about three days this pressure reached a maximum of about 80 lbs. per sq. in. The only leakage we have is what comes over the top of the seals, and this is only about 25 or 30 g. p. m. from the four seals. This leakage is picked up by a small reciprocating pump and discharged back behind the seals. We also experimented with pumping water from another section behind these seals and discharged as much as 200 g. p. m. with only a few pounds increase in pressure.

Note: We are thoroughly satisfied with the way this method of sealing is working out, and are applying it regularly in the mine.

By the application of these and other more common practices, we have been able to successfully handle a rather difficult mining condition.

ELECTRICAL MAINTENANCE PROBLEMS

(*Continued from page* 57)

a week, and all working parts placed in good order before the inspector leaves.

Inspectors for the duties outlined must be specially trained to be efficient. The average electrical repairman thinks in terms of fixing breakdowns instead of preventing them. He must be taught how to thoroughly inspect and to eliminate all faulty conditions before leaving a piece of equipment. Submitting reports of his work give a running record of the repairs of any and all equipment, and also provides a means of checking the inspector's work.

Repairs

In a paper such as this the discussion of actual methods of repairing might be considered by some the most important item; however, we do not concur in this. The important points in maintaining electrical equipment has already been briefly discussed. After a piece of equipment has failed, it is a comparatively simple matter to obtain men to repair it. The really valuable man is the one who can prevent the failure.

There are a few things, however, in the repairing of equipment which should be emphasized:

1. Use good materials.
2. Keep records.

The necessity of using good materials for effecting repairs needs little discussion. Many failures are directly traceable to the use of inferior materials from the desire to economize. This policy is one of false economy. There are already too many normal operating causes which combine to cause failures to risk adding to them the possibility of failure from inferior supplies.

There is probably no major industry more careless than coal mining in compiling records of various activities, especially maintenance of equipment. Keeping complete records of all equipment which passes through the repair shop has many advantages. They provide a running service record from which the necessity for improvements or changes in design become apparent. Causes of failures over long periods become available and methods of eliminating such failures can be determined. Too often failures are repaired time after time when a little study of records, if they were available, would have suggested a change in operating conditions or a change in design resulting in marked decrease in failures and, cost, and in the last analyses, the successful maintenance system is the one which carries on with the lowest cost.

Low Cost and Loading Machines

By W. J. Jenkins*

TO THE AVERAGE mine operator the words "low cost" and "loading machines" are practically synonymous. And rightly so, when compared to operations at the same mine on a hand-loading basis. Compared, however, to another mine enjoying similar conditions, similar equipment, similar tonnage and working time, a mechanized mine may be a relative high-cost mine.

The prime determining factor that goes for low cost is the continuity of the loading operation of the loading machine. The cost of production is indirectly proportional to the ratio of loading time to operating time.

So, instead of considering "low cost," we will consider the ratio of loading time to operating time and enumerate some of the factors that tend to raise this ratio; or rather, we might say, raise the "loading percentage."

A high loading percentage is largely the result of a perfected system of operation. The system used is determined by local conditions and the equipment available. Let's enumerate a few of the main items that enter into the picture. The system being considered in a "general layout" and in a "loading-machine crew layout":

A. *General Layout*

1. Supervision.
2. Haulage.
3. Partings.
4. Power.
5. Repair service.

B. *Loading Machine Crew Layout*

1. Supervision.
2. Section layout.
3. Size of crew.
4. Loading-machine operator.
5. Car service.
6. Cooperation.

In considering the general layout, we mean everything from the parting to the bottom, and the mine manager is the one directly in charge of this. Along this line, everything much perform like clockwork to get the maximum amount out of your property. The mine manager or some one delegated by him must be in constant touch with all portions of the mine. An adequate and dependable telephone system is absolutely essential. A breakdown on one loading-machine unit should not be allowed to hamper the operation of other units; the remaining units must be speeded up to compensate for this loss of tonnage. The men employed on this "general" territory must be advised of just what they are supposed to do at all times. In case of accident, where they are not advised, they should get in touch with the management and get their instructions. The whole thing boiled down to fact is that the operations must be directed from a central point to keep all lost motion out of the operations.

Regarding the haulage: This will probably never be settled to the satisfaction of all concerned. However, a few facts mentioned here can be taken for what they are worth.

The supply of empty cars to the loading-machine units is necessarily dependent upon the haulage, and the maximum point of efficiency will be reached only when the transportation is accomplished with the main-line haulage locomotives working at peak capacity. By this is meant each motor handling the maximum number of ton-miles. Along this line, for a motor on a given run, a certain length of trip will produce the maximum number of ton-miles in eight hours.

The only way to determine the length of trip is to chart out the time per ton-mile or time per car-mile for various lengths of trips made over the same run, and when this has been determined as far as practical, try to operate close to this peak.

On haulage ways, the rail should be heavy enough to withstand the traffic over them, with a minimum of track work. Any derailments will result in lost time not only to the haulage but on all loading machines being served by this haulage. Grading the main-line haulage road will show big returns on the investment, both by increasing the ton-mile capacity of the locomotives and by decreasing the "demand load" on the power, which is quite a substantial charge when utilizing purchased power. Along this line, the ideal curve is one that can be taken at full speed, saving the time and power necessary to again accelerate the trip to full speed. In many cases we realize that this is not possible, but every effort should be made to attain as close to this condition as possible.

A double-track haulage system is highly desirable, but is impracticable in most mines sunk some 10 to 20 years ago. In these instances the haulage must be handled on a single track, account of local conditions. In these mines the traffic must be arranged to keep the trip rolling the entire way to the bottom. These, of course, are minor problems that must be worked out locally.

Along with the good roadbed, it is understood that an adequate power supply to the locomotive is absolutely essential.

Partings

In planning the partings they must be close enough to the loading units to serve them readily, and should be amply adequate. While it is not always possible to have the parting long enough to hold two full trips, they should hold at least a trip and a half, so that when a loading unit hits good loading territory it can take advantage of it and not be held up waiting on the haulage system. It is the practice of the Consolidated Coal Company to keep empty cars enough at each loading unit to keep that unit supplied for at least one hour's interruption to the haulage system. While this sounds expensive, it is preferred to a negative expense incurred through having the loading unit idle. Should the haulage be delayed, the time can be picked up by putting an extra locomotive into service long enough to recover the cars lost by this delay.

In locating the partings it is desirable to keep them as near together as the method of development will permit, both from the standpoint of serving the units by the repair crew and from the standpoint of maintaining as little main-line haulage track as possible. With more than 10 machine units located in a mine, it will probably be necessary to make two groups.

The economy of two groups is readily apparent, compared to having the partings at all extremities of the workings.

Power

With the introduction of mechanical loading, the power supply has undergone as much change as any other item. Under hand loading, a voltage drop of 75 to 100 volts at the face was the common practice in nearly every mine in the State. However, the introduction of mechanical equipment has changed all this, for the reason that:

1. Low voltage results in loss of tonnage on practically every device operated, the loss being inversely proportional to the under-voltage operation.
2. Maintenance to equipment increases with under-voltage.
3. Loss of use while repairs are being made is an item—tends to offset expected savings.
4. With the large power consumptions necessary in mechanized mines, the operator can not afford to pay for power burned up in resistance, with no productive result. For example, under hand loading a 20 percent voltage drop at the face was not unusual. However, with mechanized loading this would result in paying a 25 percent bonus on your power, or an excess cost of a cent per ton, and in these days a cent per ton is important money.

It is the practice of the Consolidated Coal Company not to permit the d. c. voltage at the face to fall below 260 volts at any time. Toward this end, each two units are powered by a M. G. set located as close to the territories as is practical, and when voltage at face drops to 260 volts (full load), the M. G. set is advanced.

Repair Service

On the hand-loading basis where men were employed by the ton, repair service took the line of least resistance. Repairs were made when convenient, since the employe was not paid when his machine was not producing, even though no fault of the man. However, with the man employed by the day, his pay continues even though his equipment is not producing, and the surest way to keep cost down is to keep the equipment producing. This fact has produced results to a point where, at the present day, the maintenance department is probably the highest specialized department in the mine, and the men in this department are usually retained on idle days.

* President, Consolidated Coal Co. of St. Louis.

In many instances the importance of maintenance is underrated. Taking into consideration:

1. The wages of the mechanical-loading crew.
2. The loss of realization on the expected output from the unit.

The cost during the period the unit is nonproductive will run well over $1 per minute. This indicates the necessity for having the maintenance crew in close proximity to the units. The Consolidated Coal Company, at one of its mines, has 10 loading machines operating within seven minutes walk of the repair shop. While not on trouble calls, the maintenance gang works on overhaul jobs in the shop. When a call comes they drop this work, and resume it on their return. These men are trained on both electrical and mechanical maintenance and are under the direct supervision of technically trained men. While each man can handle any of the trouble calls, one specializes on loading machines, one on cutting machines, one on locomotives, one on drills and wiring, and one on substations. The round of the loading units is made by these men four times a day, even though no call for service is made, because oftentimes a defect will be noted by them and corrected before any serious delay or damage is done. During the half hour at lunch time, every machine is inspected and any necessary repairs made during this interval. On idle days each machine is given a thorough going over, with the view in mind that a "minute saved is a dollar earned."

In the underground repair shop a stock of repair parts is kept, also a spare cutting machine, drill, locomotive, etc.

As for loading machines, the ideal system is to keep a spare territory all equipped. Should a loading machine get in such shape that it could not be put in operation within an hour, the whole loading crew is transported to this reserve territory and carries on there. This system is being carried out at one of the mines of the Consolidated Coal Company with very good success.

It will be noted from the above the mine manager's duties do not permit him to spend much time sitting on the bottom figuring "all is well" as long as the cars keep coming in, because under mechanized loading, trouble is not reflected in the haulage until several hours later. Instead, he must be out "hunting for trouble" and locating it before it occurs.

Having sketched over the points in the general layout, let us get in to where the coal is actually produced. Here also, as in the general layout, supervision is the vital factor.

In the selection of bosses, it is interesting to note that some of the so-called "coal-getters" under hand-loading practice fall down under the mechanization program. The bosses have to be leaders, rather than pushers. They must have the respect and confidence of the men to get them to carry out their plans.

The statement made by one of our superintendents recently was that "unless a boss wore out a pair of shoes every three weeks he was not properly making his territory."

With this somewhat curious statement in mind, let's look into the duties of a face boss in mechanical-loading mines.

1. He must inspect and have made safe every room on his run before the men are permitted to enter of a morning.
2. He must see that proper car supply is furnished to loading machines.
3. He must see that every room is properly cleaned and safe, and center and ribs marked off after loader moves out and before cutting machine moves in.
4. He must see that rooms are properly and quickly cut.
5. He must see that holes are properly drilled.
6. He must see that holes are properly tamped with correct charge.
7. He must see that track laying is kept up in proper shape to facilitate fast loading.
8. He must see that rooms and crosscuts are turned at proper places.
9. He must see that car changes are made in proper manner to expedite car changing and prevent his various operations from interfering with each other.
10. He must see to it that the loading machine makes "moves" as short as possible.
11. He must see that the timbering is kept up to keep places safe.
12. He must keep an adequate amount of supplies on hand at convenient places.
13. He must see that there are always enough loadable places on hand for the next day's work.
14. He must at all times instruct the men as to proper and safe methods and see that they perform their duties in this manner.

And after having done all these things and kept his parting full of loaded cars and his cost down lower than any of his associate bosses, he can then sit down and save his shoe leather.

From the above, it is quite apparent that "bossing" is not what it used to be. Still, as one of the old timers expressed it, "I like it, since there is something doing every minute."

Section Layout

This will unquestionably vary with every company and every mine. However, the section should at all times be laid out with the cost feature in mind.

As to the number of crews a boss can handle—this will vary with different companies, and may vary from one to four crews, according to the individual ideas of the management.

Our own company has adopted the plan of one boss for two loading units as being the most economic layout.

With this in mind, taking this figure, the territory is laid out so that the two units do not interfere with each other and, further, that the several operations of each crew do not interfere. The layout should be such that the relay motor can keep the service motor supplied with adequate empty cars and take away the loads. This means good road, not only on the entries but in the rooms as well, since derailments mean delay. The turns should be of ample radius. As a general rule, double the radius used in the mine during hand loading and you will be about right. This makes for high-speed transportation.

The room width, of course, depends upon local conditions and the type of car change on the room width. The *average* car change time should not exceed 45 seconds in good operations. It can be kept lower, but if cost of doing so offsets the gain, the result is not desirable.

One of the most important things in the section layout is to keep the haulage ways clear and keep the rooms in such order that the loading machines do not have to do extra moving and digging to clean up a place. When a place is cleaned up the crosscut should be large enough to permit the loading machine to move through the crosscut into the next room, without having to go clear to the entry.

The Loading Machine Operator

In all cases, the choice of an operator can not be stressed too strongly. Since he is placed in charge of the most vital piece of machinery on the job, he should be a man endowed with the power of leadership. With the men on the crew respecting his ability, they strive to make things easier for him and to help him in trying to lead other operators. He, likewise, should be a willing worker, and in performing his work leave as little unnecessary work for the rest of the crew as possible. The loading-machine operator might be classed as the star performer on the crew, and one with a radical viewpoint will soon ruin the morale of the whole crew, in spite of the efforts of the boss.

Car Service

The question of car service is one of general disagreement, the choice being between cables, mules, battery motors, and cable reel locomotives.

Storage-battery locomotives have been chosen by the Consolidated Coal Company as the ideal type for our mines, on account of their combined speed, power, and flexibility, and in our opinion the most economical to operate. They are on about par with the cable reel regarding speed and power, except in mines with excessive grades. Regarding flexibility, they do not have to return the same way they enter, which is extremely desirable in mechanized practice, and their power requirements or charging load is carried at night and not added to the already high peak day load. On the relay or swing motor there is not much choice between the storage-battery motor and the cable-reel locomotive. However, to keep equipment as interchangeable as possible, the Consolidated Coal Company uses the storage-battery locomotive on all but main-line haulage service.

Cooperation

To get the most out of all the above-mentioned items, cooperation is necessary among the entire crew, and if the operations are directed properly a spirit of rivalry develops among the different crews, each crew trying to outrank their rivals; the loading operator tries to set a high mark on cars loaded, the motormen to set a record on cars pulled. This spirit carries the balance of the crew along with it, and at quitting time you will probably overhear the settling of bets as to who had the low tonnage and had to "buy the cigars."

A very humorous case developed at one of our mines, where a loading-machine operator who had an extremely good territory had the ambition to try and load as much coal as both operators on a less

(*Continued on page* 68)

Tonnage, Loading, and Development Work with Track-Mounted Machines

By John H. Richards*

Discussion by John R. Foster†

TONNAGE and development are the two vital factors in successful operation. A suitable tonnage must be maintained to reduce certain fixed charges to a minimum. The proper territory must be developed in order to insure the proper tonnage at all times. Modern methods and machines have made it possible to concentrate underground work. With mechanical mining, it is no longer possible for a mine superintendent to check his development by noting the percentage of narrow coal on the tipple sheet. He must know that the development is being made in the proper place. The purpose of this paper is to explain to you the methods that have been developed by the Hanna Coal Company for use with track-mounted machines.

Development Group

The purpose of this group is to drive the main headings and extend the room entries a certain set distance. There are eight men in this group, the work is divided as follows:

Occupation	No. men
Machine operator	1
Motorman	1
Brakeman and Whaley helper	1
Coal cutters and drillers	2
Trackman	1
Trackman helper	1
Bugduster and shooter	1
Total	8

The standard tonnage for this group is set at 157 tons. This tonnage is considered as 100 percent efficiency. The composed of 17 men and is set up as follows:

1	Loading machine operator
1	Loading machine helper
1	Motorman
1	Snapper
2	Cutters
1	Trackman
1	Trackman helper
1	Driller and shooter
1	Bugduster and driller helper
2	Slate drillers and posters
5	Slatemen
17	Total on combination crew

The method used in advancing a pair of room entries is shown by Figure 1. The standard daily tonnage for this group is set at 391 tons. We have reached a daily production of 352 tons or

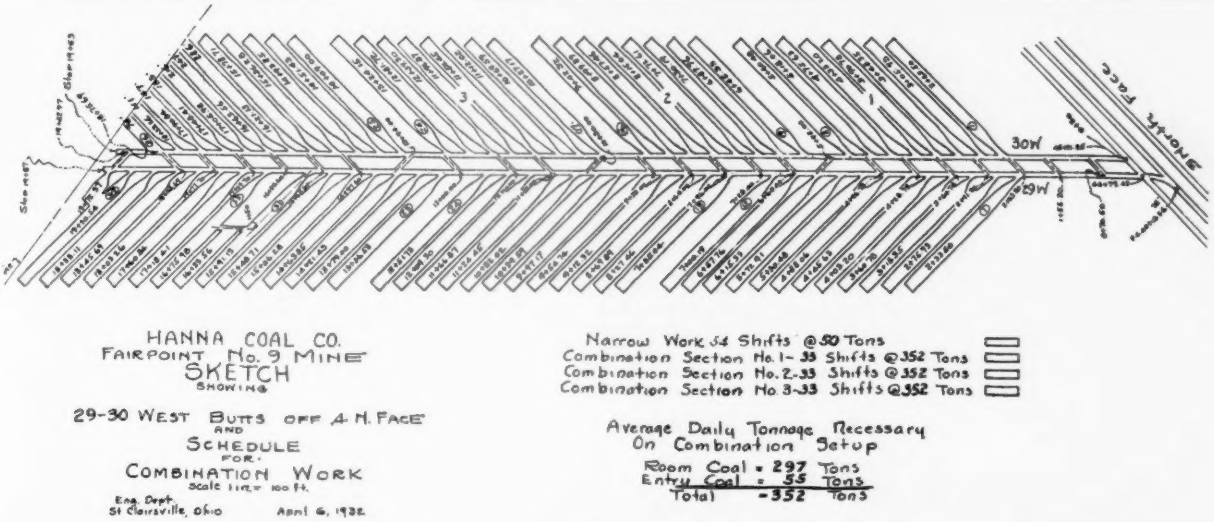


Fig. 1

In setting up our tonnage for track-mounted cutting and loading machines, we found it necessary to classify the work into three groups—Development, Combination and Production. Each group having been set up after detailed time studies were made, thus insuring proper coordination of effort for each member of the crew. The set-up of these groups and the duties assigned to each are as follows:

average production from this unit has been 130 tons.

Combination Group

This crew follows up the development group in the room entries, developing the room entries, opening up its own territory and working out one side of the room entry as it advances in blocks of eight rooms. When the entries have been advanced their limit, the remaining solid side is worked on the retreat, with a production group, in blocks of 12 rooms. The crew for the combination group is

90 percent efficient with this unit. It is necessary to watch the tonnage from the rooms and entries, in using this method, to be sure that it is properly divided so that the proper amount of development is made for a new set of eight rooms, each time a block of rooms is finished. Figure 1 shows the lay-out for a room entry. In this particular lay-out there are three moves for the combination unit. The number of shifts is shown for each section together with the necessary division between room coal and entry coal.

* Chief mining engineer, Hanna Coal Co.
† Superintendent, Chicago, Wilmington & Franklin Coal Co.

Production Group

This group works entirely in rooms and is composed of 18 men. The work of this crew is divided as follows:

1 Loading machine operator
1 Loading machine helper
1 Motorman
1 Snapper
2 Cutters
1 Trackman
1 Trackman helper
1 Driller and shooter
1 Bugduster also driller helper
2 Slate drillers also post rooms
6 Men cleaning and gobbing slate
—
18 Total for production group

The standard tonnage for the production crew has been set at 428 tons. In actual practice, these crews have attained an average daily tonnage of 95 percent or 407 tons.

We have found that the proper rotation of the different classes of work is necessary to insure a steady production from each group. Figure 2 shows the lay-out of the work and distribution of labor for a production group.

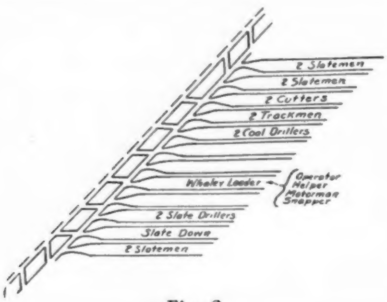
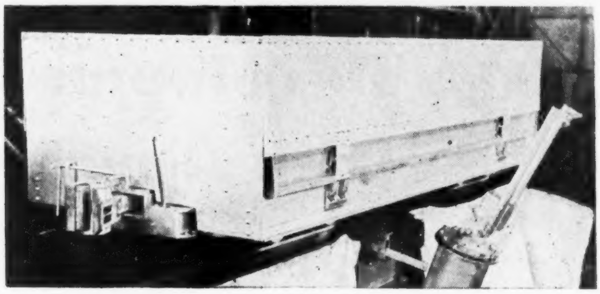


Fig. 2

In order to create an incentive for each group to produce a steady tonnage, a bonus system was established. The standard tonnage or the tonnage for each group working at 100 percent efficiency was set. When the tonnage of any group reaches 80 percent efficient for the pay period, ½ percent of the base earnings of the entire crew is distributed equally among the members of the crew. This bonus increases as the percentage of efficiency increases until at 100 percent efficient, 15 percent bonus is paid. Some of our crews have attained an efficiency of 95 percent, thus earning a bonus of 10 percent.

One of the contributing factors to the successful operation of the system, as we now have it set up, is the use of a new type mine car. This car is manufactured by the Differential Car Company. It is all metal and has a unique dumping arrangement. With 93 of these cars and the use of a 200-ton bin, we are able to maintain a steady flow of coal into the tipple. Figure 3 shows the type of mine car being used. These cars are fed to the Whaley loading machines by the use of battery locomotives. Eight of these cars will clean up a cut in a wide room. After the cars are loaded and the trip assembled, they are hauled to the tipple, dumped by means of a compressed air dumping arrangement as they pass over the bin. It is not necessary for the haulage motor to cut loose from the trip. Cars are not left at the tipple as they are returned to the inside as soon as they are dumped by the same motor that brings them out.

Fig. 3



In order to maintain a certain set daily tonnage, it is necessary to forecast the moves of each group. At the end of each quarter, the work is planned for the next three months. The estimated dates for the moves of each group are shown on copies of the mine map. This information is furnished to the superintendent and mine foreman who find it quite necessary in this type of work.

JOHN R. FOSTER—
Chicago, Wilmington and Franklin Coal Co.

At the beginning of Mr. Richards paper he has shown the need of classification of machines in mechanical loading in order that number and personnel in each crew can be authorized according to the potential capacity of the machine involved. This is essential if capacity of machine does not justify full crew.

The developing system of mining as outlined does not give the same potential capacity therefore the number in the crew can be reduced accordingly and costs obtained more in line with straight room machines.

The coordination of the development with room work is very essential and must be constantly under control if steady tonnage is to be maintained. It is the duty of the engineer and superintendent to always have this factor under control as advance development is not desirable beyond the actual needs.

In the Orient mines the mining system is somewhat different where main and cross entries are to be driven. We have found that the entry driving machines are very successful when rapid advance entries are desirable and by driving the main entries with this machine we are very successful in operating our cross entry and panel development with one development and 4 room machines. Each section with 2 foremen.

Our entry drivers will advance 100 ft. per 8-hour shift with a crew of 2 operators; 2 helpers; 2 motormen; 2 tripriders; 2 trackmen and 1 foreman.

The developing machine will have 11 entries to load each day and room necks that give this machine practically the same capacity as the room machines. As the traveling speed of the track mounted machine overcomes the distance between the loading points to the comparative distance in rooms, therefore our developing crews are very similar to crews working in rooms, as the potential tonnage is similar with track cutting and shearing developing crew. One operator; 1 helper; 2 drillers; 2 cutting machinemen; 1 motorman; 1 triprider; 1 trackman; 1 timberman; 1/3 foreman. Potential tonnage, 280.

The crew for the room machine is the same except 1 foreman in charge of 2 machines with an average capacity 300 tons.

With larger cars track machine development tonnage can be improved as car change time is usually longer on development work than in rooms. With the above developing system room necks are opened up and panel is ready for full occupation by room machine without drop in tonnage, which means a steady production from our machines with no fluctuation when one panel is worked out and units must move into new sections.

MAKING FALLS SAFELY
(*Continued from page* 49)

small pipe with a piece of sharpened steel fitted into one end. By the use of this tool, workmen are protected by standing timber or may stay back under good roof and recover supplies mentioned above.

Although the pulling of timbers was originated primarily as a safety measure, we have the foreman keep a complete record of number and dimensions of salvaged timbers. It might be interesting to note that under this scheme of pulling timbers we have not only accomplished our purpose of making our pillar falls on time and adding to the safety of our pillar work but we are actually making money on our salvaged timbers. At one of our mines during last month we showed a net saving of .016 cent per ton in timber purchases, or approximately 40 percent reduction.

LOW COST AND LOADING
(*Continued from page* 66)

favorable territory. While he has never quite accomplished the task, nevertheless, during the last two months of the wage agreement he has come within less than 5 percent of doing so on six or seven occasions. To prevent him from entirely breaking the spirit of the two crews, the gossip locally is that we plan to make a face boss out of him on the resumption of operations.

Cutting Machines with Conveyors for Conveying the Cuttings

By L. W. Householder*

Discussion by L. N. Thomas†

SINCE the introduction of the continuous or endless chain cutting machines in coal mines to replace the hand picks, air and electric punches for undercutting coal, there have been numerous types, kinds, and classes of cutting machines invented, built, and experimented with in coal mines. Inventors have wasted years of valuable time inventing and developing all kinds of freak machines; manufacturers have spent millions of dollars building these machines, and any intelligent, practical miner, after a few hours investigation of their ideas and their machines, could have told that a number of these machines were impractical and would not be successful in actual operation. Inventors and manufacturers knew too little about the inside conditions, and what was required of the mining machine.

The one phrase used by all inventors and manufacturers of these various types of machines was: "The machine is all right—change the conditions in your mine to suit the machine. The machine will work, but your conditions are not right."

Manufacturers had the mass-production bug and wanted to build one standard machine that would suit everybody and every coal mine. The same general practice applies to loading machines, conveyors, cleaning plants, and other types of machinery.

There is one thing certain; you will find in every coal mine, and not always on first inspection, that the roof has peculiar characteristics, the bands of impurities are always present, clay veins and rock rolls show up at the most inopportune time; high sulphur and high ash streaks of coal are with us in every seam if we look for them. If we don't the customer will, and will tell us about them. The coal customer demands that the operator put the best coal he can possibly mine on the market at an extremely low price.

True, if we were forming the coal beds we think we would do it differently, but we know very little of the troubles old "mother nature" had in the formation of these coal beds, with all the troubled, changed conditions that existed in the ages in which coal beds were formed. One thing sure, every seam of coal in every locality has its own particular troubles, its own peculiar roof conditions, clay veins, high sulphur and ash bands, and nothing can be done to change them. So there is just one thing left for the operator to do, face the problem and solve it. But you hear the common outcry from every coal operator: "How can I solve it and meet present market conditions?"

The operator has made mistakes; he has told the manufacturer of mining machinery to go ahead and develop this or that type of equipment, for which he will find a large market. After the equipment was built and proven successful, it developed that the operator had not analyzed his market conditions correctly, as well as other factors, and as a result both the time and the money spent in developing this particular piece of equipment were lost.

Mechanical mining and cleaning plants have been completed at several mines to meet the market conditions. They have failed in some instances and now stand like giant ghosts, a ghastly monument to the engineer who designed them, and to the executive who authorized the expenditure for them.

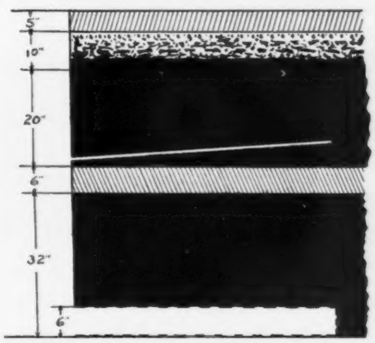
Instances such as I have enumerated above only indicate too clearly that insufficient time, study, and research work have been given to the solving of the mining problems and, consequently, tremendous amounts of money have been wasted and a large quantity of machines and equipment developed that have proven failures.

Several years ago we convinced one of the largest manufacturers of mining equipment that if they expected to sell mining machinery to our company they must build machines to meet the conditions that exist in our mines; that their present type of mining machine was not suitable for our conditions, and we could not justify the expenditure for new machines unless certain important features were changed.

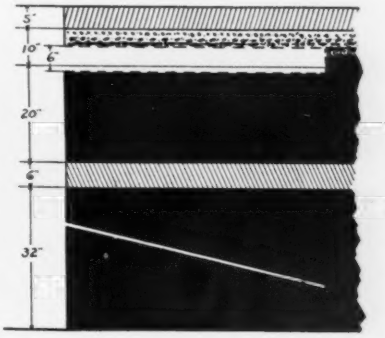
After several conferences with executives of this mining machine manufacturing company we finally decided on a definite policy; they sent their designing engineers to our mines to stay a month, two months, then three months, and finally six months. They consulted with our engineers, our practical mining men, studied conditions that existed, and the outcome of all this work is the present type of machine which I will describe.

The cuttings are collected, and through a system of conveyors are conveyed to the rear of the machine, and can be loaded directly into mine cars or, if it is permissible to gob the cuttings in the mine, the conveyor can be turned at right angles and the cuttings deposited along the side of the rib. This machine has been working for over a year, and has proven very successful from the standpoint of maintenance and economy.

To illustrate, or describe briefly, I will outline two particular problems we have solved with the present machine:



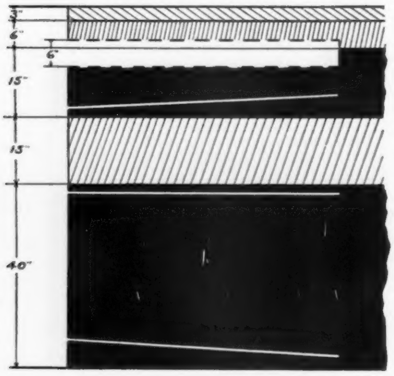
You will note from this slide that the coal was undercut on the bottom, holes drilled above the impurity band, and the coal all shot down together. We found that the impurity band (low-grade cannel coal) was broken up in very small pieces, making it impossible for the miner to clean; also, part of the high-ash coal from the roof would come down and mix with the good coal. Further investigation proved that this coal could not be mechanically cleaned due to the fact that the impurities were of practically the same specific gravity as the coal, so another system had to be advanced.



Coal was cut on the top, holes drilled in the bottom coal and shot up. Top coal broke up in large blocks which could be removed and loaded into the mine car

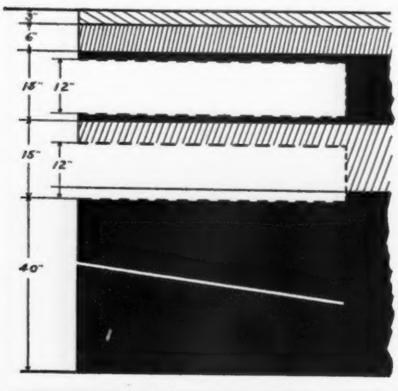
* Vice President, Rochester & Pittsburgh Coal Company.
† Carbon Fuel Company.

without any extra effort on the part of the miner. The impurity band was also broken up into very large slabs and could be gobbed or loaded into the mine cars without any extra effort on the part of the miner. No trouble was experienced with the roof coal coming down and mixing with the clean coal. After the binder is removed there remains the bottom bench of clean coal, free from all impurities, and it could be loaded into the mine car without any attention to cleaning at the face. The cuttings from the top cut could either be loaded into the mine car and handled separately or put into the gob, as conditions warrant.



Problem No. 2

This is the double Freeport seam, with 3 in. of low-grade cannel coal on the top, 6 in. of high-ash and high-sulphur coal, 15 in. of high-grade coal, 15 in. of slate binder, and 40 in. of high-grade coal. We have tried several systems, and the cutting on the top, as shown on this slide, has given us the best product, but has had its troubles and means a great deal of extra work on the part of the miner, resulting in a great deal of dissatisfaction.



We increased the cutting kerf by adding another cutter bar, to 12 in., cutting out the good coal in the top bench, loading the same into the mine cars with the machine, then dropping the cutter bar and cutting out the binder, as shown. This could either be loaded directly into the mine car with the conveyor, or the conveyor turned at right angles and the cuttings put into the gob, whichever was desired. A wall to hold the cuttings from running down over the track could be built out of the core left in the binder by the double cut. This method insures clean coal, has proven very successful, is well liked by the men, and is a very economical operation.

Numerous experiments are being carried on with different types of machines. We are thoroughly convinced that the operator must solve his own problems with the assistance of the machine manufacturer. First, the operator must definitely make up his mind what kind of a product he wishes to produce. Second, be definitely sure that the system he has outlined will produce this product. Several actual experiments with some sort of temporary machines should be conducted before undertaking the manufacture of a special machine for a particular job. In other words, the cost of developing new machinery is naturally high, and the manufacturer or the coal company can not afford to spend money developing particular types of machines for special purposes unless they are absolutely sure that these machines will produce the results desired, and the operator wants to be doubly sure that the results he desires will satisfy his customer, because ultimately the customer is the judge.

And in conclusion will say that the successful coal operator of the future will be the operator who can produce a solid fuel that meets the requirements of the consumer, at a price that has an advantage in favor of the solid fuel over the liquid or gas fuel. Anything that materially increases the price of solid fuel only adds more customers to the producers of liquid or gas fuel at the expense of the coal operators.

L. N. THOMAS—*Carbon Fuel Co.*

IN CARRYING ON this part of the program, instead of commenting upon the paper which has just been given, the writer has been asked to discuss the overcoming of rather severe natural obstacles to face preparation by mechanical means.

Since this particular task was described in some detail in a paper last year, this discussion, after a brief review of the method of face preparation, will be confined to an explanation of the ways in which face preparation is sometimes affected by the mining layout and how this layout must sometimes be altered to enable a previously arranged face preparation scheme to be worked effectively.

The cross section of the Powellton seam of coal in the No. 9 mine of the Carbon Fuel Company, starting at the top, is 1½ ft. of coal, about 5 in. of gray splint, 18 in. of coal, 1 in. of slate, 1 ft. of coal, 18 to 33 in. of slate, and 3 ft. of coal—a total of about 9½ ft. with an 18-in. cap coal above.

As the cleaning plant outside very effectively removes the gray splint and 1-in. band of slate, the problem on the inside preparation is the removal of the large slate band. In doing this work, the chief mechanical device is a Goodman slabbing machine.

The cycle of operations is as follows:

Starting with a cleaned up place, the machine enters and cuts in the coal directly above the large slate band. The machine cuttings are loaded by hand while the machine is moved to the next place. Three horizontal holes are then drilled in the top. Three holes exactly parallel to and on the slate bottom, and from three to four holes directly under the slate band. The holes under the slate are then loaded and shot. The machine crew now returns, sumps into the slate and rakes it out on the floor. The preparation crew picks all loose pieces of slate out of the back of the kerf and carefully sweeps it—after which the loading machine enters and loads the slate into the mine cars. The face is now swept, and also the floor for a distance of 12 ft. back from the face. The top and bottom holes are then shot and the coal is ready for loading. Due to the difference in the characteristics in the two benches, the most satisfactory product is made when they are thoroughly mixed at the face.

At the time this plan was described last year, this face preparation scheme was working very satisfactorily in entry driving, but no room work had been tried. It was planned to drive rooms on both sides of a three-entry system 30 ft. wide on 40-ft. centers. After the rooms had been driven 200 ft. deep, it was planned to slab back 7 ft. of the remaining 10-ft. pillar.

After considerable experience with this layout, it was found not practical from the standpoint of face preparation, for the following reasons:

1. Due to the thickness and the very soft structure of the coal in this seam, by the time the 200-ft. depth had been reached large quantities of the top bench of coal along the ribs had sloughed off. This coal covered the slate band and bottom bench—making it impossible to get to the slate or bottom bench until the top bench was loaded separately.

2. The slate became crushed and mixed with the top bench in such quantities that, when loaded, this material overloaded the cleaning plant. The remaining slate could not be raked out because the top bench would not stand while this operation was being performed.

3. The 24 in. of cap coal, due to pressure and inadequate support, came down with the top bench.

4. It was not felt advisable to simply drive the room up and leave the pillar because the pillar is not sufficiently thick to properly support the top and not sufficiently thin to allow the top to fall—either of which is necessary in order to prevent top pressure from riding over into new work.

Since the face preparation scheme had been and was successful in entry driving, the practical solution to the problem seemed to be the altering of the layout of the rooms rather than the modifying of the face preparation scheme to the present room layout. Therefore the room centers were doubled and the room width was narrowed 5 ft.—making rooms driven on 80-ft. centers 25 ft. wide, and leaving a 65-ft. pillar. The new scheme, therefore, planned a 35 percent recovery on the advance instead of the 80 percent under the old arrangement.

As soon as the rooms reach the 200-ft. depth, a butt-off is driven parallel to the entry. The crews are then dropped back and a pocket 25 ft. wide is driven on an angle of 45 degrees through the pillar. Five or 6 ft. of coal is left between this pocket and the butt-off. Having completed this pocket, the crews are dropped back and another exactly parallel is driven. Each time the same 5 or 6 ft. of coal is left between the present work and that immediately preceding.

In following this scheme, it was found that very little rib sloughage took place in the rooms as they were driven. Although the experience so far has not been sufficient to prove definitely, there has not as yet been sufficient weight to bring down the cap coal. The face preparation can therefore be maintained up to standard and delays and interruptions to the working cycle from this source have been eliminated. This scheme has so far had the further advantage of making it possible to maintain the section tonnage output uniform on both advance and retreat.

It is therefore felt that the layout as now arranged allows effective and economical face preparation in this particular seam of coal.

SUPPLIES UNDERGROUND

(*Continued from page* 58)

lays. Whenever the supplies of the underground shop are exhausted they are replenished from the regular stockroom on the surface.

In this main shop on the bottom a motor is kept, to be used for conveying supplies to any part of the mine when it is necessary to make an especial trip.

The repairman turns in a report at the end of the shift and charges the supplies to the machine that has been repaired. In the office these reports are entered on a card for each machine, and from these cards the cost of machine maintenance is closely watched. Any carelessness of operation or maintenance is located at once, for these records are kept on all loading machines, cutting machines, and haulage motors.

You may think that this method involves too much clerical work for the repair men, but they can make out these reports in five minutes These reports are then turned in to and tabulated at the office.

On certain types of loading machines the oiling is a serious problem. The old haphazard method used in oiling cutting machines and motors will not work on loading machines. It is too expensive, and the results of careless oiling soon show up in the cost of supplies. To overcome the oiling problem, one company built up an oiling truck equipped with a pressure tank, to which was attached a meter for the purpose of keeping an exact record of the amount of oil used on each machine. This truck is equipped with an automatic Zerk gun, so that the machine is oiled and greased at the same time by one crew. The amount of material used is recorded and charged to the machine. A report of the amount of oil and grease used is left on the machine for the operator, the repairman, and the foreman. Then a copy of this report is sent to the office, where it is entered on the machine card. Thus, an exact lubrication cost is at hand and quickly shows up a machine that needs attention. Since this method of handling repairs and lubrication has been installed, the repair cost on a machine has been materially reduced and the amount of repairs to be kept on hand has been reduced 30 percent. Also the oil cost per ton is about one-fourth as much as formerly.

The trailing cable on the different pieces of equipment in coal mines is given the least care and causes the most unnecessary delays of any single piece of equipment. It is abused through careless operation, run over, crushed by falls, kinked and pinched. When it blows up it is hurriedly spliced and given no more attention until it blows up again. I would like to call your attention to U. S. Bureau of Mines Report of Investigation 3154, called "The Splicing of Rubber Sheathed Trailing Cables," by L. C. Ilsley and A. B. Hooker. May I suggest that you read it carefully, for it contains many practical suggestions. If you will make use of them you can prevent many cable failures and thereby increase the life of your cables and reduce cable cost. Past experience has taught me that correct spicing of cables has reduced cable costs.

Many methods of handling underground supplies could be cited, but they would all point to the one general rule. Have all supplies necessary for the work at the place where and when they are needed, but dont' have an oversupply and *don't* leave them laying around after the job is completed. Show your men a workable method of handling supplies, give them the necessary conveniences to put it into effect, and then see that they do it.

If there is a careful, economical handling of supplies, their recovery will be reduced to a minimum, and that phase of operation will naturally take care of itself.

SAFETY IN BLASTING

(*Continued from page* 51)

escaping with the expanding and liberated carbon dioxide through the ruptured disc are far below the temperature of methane ignition. The amount of carbon dioxide compressed into the cylinder is ample, if sufficient to burst the disc, to quench the flame from the heater. Electric arcs from the blasting magneto that might result at the naked parts on the inby end of the cable may be formed if the magneto is sufficiently powerful. This hazard can be removed by having a magneto that will generate a maximum arc too weak to ignite fire-damp but sufficiently strong to fire the heater match.

My fourth demand is rather well complied with because of the slowness in the discharge of Cardox. Pressure here, of course, is equal in all directions. The time element, however, is an important factor in preventing damage to the roof and walls. The blast resembles a heaving of the material, the heaving action continuing after the initial blast because of the expansion of the CO_2 as it permeates the fractures caused by the initial shock blast. The roof and walls are not as much affected as they would be from a sudden and violent blast penetrating into the solid in a sort of inverse ratio to the time element because the breakage of coal to be loosened is not sufficiently sudden for the release and maximum benefit of the blasting force. In this, loosened roof and walls, and flying coal are reduced. However, unless chance is given for the coal to be properly blasted, a flying shell may result.

By virtue of the five imaginary demands I have laid down, the handling and storage hazard is removed. This, too, is embodied in the Cardox method. There is no need of special storage on the surface or in the mines. A lost or misplaced shell is not a hazard; simply a lost piece of equipment.

While Cardox does not quite reach the strict demands I have made for attainment of the 0 percent of hazards, it makes a close approach. With training and a more general knowledge of this relatively new blasting device this 0 percent can be even more closely approached coupling with it an increased quality of product.

Experience in the Cardox method of blasting substantiates the prophecies made for it. But blasting accidents have not been the only ones reduced. The firmness of roof and walls produces a less hazardous condition within the mine, a hazard that results in approximately one-half the injuries sustained in coal mining. The less shattered condition of the coal is also a safety factor in loading.

In its reduction of the individual type of accident and of the disaster, Cardox is an important step in the progress of the twentieth century.

COAL MINE POWER DISTRIBUTION

(*Continued from page* 60)

adjacent mine operating loading machines identical in type, armature failures were almost unknown. The machines in each mine were operating under almost identical conditions. Power readings were taken at no load, full load, each conveyor running, and power at which each clutch slipped on all machines at each mine. These readings were then plotted so as to show graphically a comparison of the power requirement. The results were surprising in that it showed the faults were in the mechanical adjustment rather than electrical conditions. Needless to say, corrections were quicky made, and an armature failure in loading machines at this mine did not occur again for almost a year. Tests of electric equipment are now made periodically, and results are more than justified by a reduction in the time lost and maintenance costs.

The use of electricity in any form in coal mines covers a period of not over 50 years. We have only to harken back a few years to remember when the pick, shovel, and a bundle of dry squibs were the principal implements of mining.

The cutting of coal mechanically was the first great step in doing away with the arduous labor of "digging" coal.

Only in the last decade, or since the advent of successful loading machines, can we definitely say that the drudgery has been taken out of coal mining. It is only by looking back upon each step of the progress made in mine mechanization that we can come to a true realization of the important part that electricity has had in the development of mine mechanization. Without a doubt, coal-mining practices and equipment will be so advanced over present-day methods that the next generation will regard us in the same light as we do the antique methods of our ancestors.

Premium Payments for Mechanical Loading

By I. N. Bayless*

THE subject of Premium Payments for Mechanical Loading was given consideration by the management having in mind they would prove an incentive for increasing the tons per man shift, make for a lower production cost and allow the ambitious workman an opportunity to augment his earnings over the regular day wage rate, a standard of performance having been established by the operator which would be expected from the employe. Any performance above the standard is looked upon as a saving to the operator of which the employe benefited to the extent of receiving a certain percentage of the saving effected. The premium must be high enough to be worth while to the employe and low enough to insure a saving to the employer. This method of sharing tends to pay men in accordance with their ability and effort.

One of the principal advantages of this method of sharing is that a better class of labor may be attracted. Greater earnings furnish an incentive to increased tonnage. Workmen who prove themselves aggressive are readily noticed by supervisors, and, by shifting men to different places and to different working conditions, the crews are made more efficient and the inefficient workmen may be singled out and eliminated, thus permitting better results and better operation of the mechanical loading equipment. This is also evidenced by the fact that men become their own competitors, also working in competition with other crews. In order to do this, without neglect to the care and protection of the loading machines, men are educated to the proper handling and care of the machinery, keeping it in shape and everything clean in general which has shown good results.

The establishment of premium payments has assisted in breaking down the passive resistance to establishing record shift tonnage. Men have always had the feeling that a certain fixed number of cars should constitute a maximum shift, regardless of whether or not this figure could be easily exceeded. Any crew loading exceptional tonnage was criticized. The payment of premiums has broken this situation up and this one thing has been a great benefit.

Too much importance must not be placed on the material benefits to the workmen but the management should realize and stress the fact that workmen have spiritual and intellectual interests as well. Employes should be encouraged to secure the greatest possible satisfaction from the honest performance of their duties. An opportunity is afforded to emphasize teamwork and cooperative effort rather than individual self-interest.

It was feared that the tendency of workmen would be to sacrifice safety for speed in their effort to earn the premium. A perusal of the safety records of The Union Pacific Coal Company will prove that the safety record has shown improvement and that the crews are constantly becoming more efficient.

Some difficulty was experienced at our Winton mines when the workmen refused to accept the premium earned. It was found that the district president of the Mine Workers' Union had left the impression with the local organization at Winton that he disapproved of the method of premium payments which resulted in the refusal of the men to accept their premium checks. This was shortly overcome and within a period of six weeks the money had all been paid to the men, no further difficulty of this kind having been experienced. Some inconvenience, however, was met with by the refusal of the men to accept their premium payments as it was necessary to cash the checks and hold the amount of premium until the question had been satisfactorily settled.

The management, as an added stimulus, worked out a plan of payment of premium by separate check which was put into effect January 1, 1931. These checks are issued for the amount of premium earned and are not subject to deductions of any kind.

In some cases there was a lack of standardizing of the work of employes. Of necessity, conditions are not the same in each of the 10 mines operated by The Union Pacific Coal Company and where premium may be earned easily in one place, there may scarcely be an opportunity for earning a premium in another. It was felt that this difficulty would adjust itself over a period of time just as it has done under hand loading methods.

Experience has taught that when workmen are hesitant to accept new plans or proposals it is because they feel that their jobs may be made less secure—to overcome this requires the development of confidence in the integrity and fairness of the management.

In view of the foregoing, and with the knowledge at hand, the practice of premium payments was established in The Union Pacific Coal Company mines. During February, 1930, one shaking conveyor in each of the mining districts was selected and set up in as similar mining conditions as was possible. The crew for these conveyors consisted of four men; three men at the face doing cutting, drilling, shooting and loading, together with setting of any necessary timbers for the safety of the place; and one man at the car or loading head. These crews were to be given every opportunity to load as much coal as possible. The average minimum tonnage of 15 tons per man shift figured over a period of two weeks was the base, and for each ton loaded in addition to the 15 tons per shift the men received 12½ cents. The amount earned through the loading of additional tons was divided equally between the men of the crew and payment for same was made twice a month, as is payment of their regular wages. For example, if a crew of four men worked eight days of the two weeks period, loading 520 tons in that time, the premium to be computed on 40 tons of coal, which represents the amount of coal over the base established. Forty tons at 12½ cents per ton amounts to $5, or an average of $.156 per man shift. This system proved to be satisfactory and by May of 1930 all the shaking conveyor crews were operating on an equal basis with the same opportunities to earn the premium offered. After a few months of practice it was developed that the amount of premium should be increased, and effective May 1, 1930, the rate for each ton over the base of 15 tons per man shift was increased from 12½ cents per ton to 25 cents per ton. This rate still prevails. Some interesting figures in this connection follow: During the period May 1, 1930, to December 31, 1930, 31 percent of the shaking conveyors operating had earned a premium. The shaking conveyors earning premium produced 39.9 percent of the total amount of coal loaded by this type of machine, or 18.2 tons per man shift. The amount of premium earned during the period was $12,004.63 which amounted to $.811 per shift. The average tons per man shift of all shaking conveyors was 14.0 tons.

A decided improvement will be noted in the following figures which cover the operation of shaking conveyors for the year 1931. An average of 65 shaking conveyors were in operation during the year, of which 56.6 percent earned premium, producing 67.3 percent of the tonnage produced by these loaders. The amount of premium earned was $31,142.49, or $.822 per shift. The average tons per man shift for all shaking conveyors was 15.9 tons.

The mining conditions of The Union Pacific Coal Company property located at Hanna, Wyo., are very unusual, the seam being from 25 to 35 ft. in height. The mechanical loaders in use are Joy loaders and scrapers, the bulk of the coal being produced by Joy loaders, using the scrapers only during times of peak demand for the coal.

The first operation of mining the coal of this high seam is what we term "pioneer work" which consists of driving development entries and removing the first 8 to 10 ft. of coal in rooms by the use of cutting machines, drilling and shooting in the ordinary manner, except that, in order to have a level floor in the room, there is left from 5 to 7 ft. of coal on the down hill or low side of the room. The coal thus shot down is then loaded out with Joy loading machines.

The balance of the coal, or what is termed "top coal," is then shot down in sections and is loaded either with Joy loaders or scraper loaders. At the top is left a roof of dirty coal from 6 to 7 ft.

(*Continued on page* 93)

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Vice Pres.,

Pittsburgh Coal Co.

Coal Cleaning

Dr. L. E. Young

Chairman

Safety

E. W. Judy

Chairman

Vice Pres.,

Harwick Coal & Coke Co.

Economies to be Effected by Cleaning Coal

By Byron M. Bird*

Discussion by

Chas. W. Connor[1]

K. A. Spencer[2]

Jos. Pursglove, Jr.[3]

L. A. Osborn[4]

W. J. Schenler[5]

INTRODUCTION

MOST writers on the economics of coal cleaning have discussed the subject from the standpoint of the user—that is, they have been mainly concerned with advancing arguments for buying clean coal. In this paper I wish to deal with the subject from the standpoint of the coal operator—that is, I shall be concerned with the factors that determine whether he can clean his coal profitably. Since the importance of these factors varies greatly at different mines, I can only point them out and leave it to the individual operator to apply them to his particular case.

I shall attempt to cover in a general way two phases of the economics of coal cleaning: (1) What are the sources of profit to the operator from coal cleaning? And (2) if an operator cleans his coal, how can he make the cleaning operation most economical?

SOURCES OF PROFIT FROM CLEANING COAL

The most obvious source of profit from cleaning coal is a premium price for the prepared product. Should the operator expect to obtain this? He should, certainly, if he uses his own coal. Many companies, such as the Steel Corporation, find that security of supply and uniformity of price justify them in owning their own mines. Since cleaning coal enhances its value and since those companies owning their own mines receive all the benefits, they in the last analysis receive premiums on the form of a better fuel, a better grade of coke, a lower freight cost per pound of combustible, and the like.

But how about the operator selling on the open market? Should he expect to obtain a premium price for clean coal? Yes, in some instances, where circumstances favor him. If he has customers to whom low ash or low sulphur content is important and who wish to use his coal, either because the freight haul is short or because his coal has a low volatile content, good coking properties, or some other favorable characteristic, they will usually pay a premium amounting to a part at least of what the cleaner coal is worth to them. However, these cases are comparatively exceptional. Experience shows that generally the coal salesman in a highly competitive market has found it advantageous to forego a premium price and to use the fact that his coal is cleaned as a selling argument to get business. Thus, with most companies cleaning has actually become a sales promotion scheme. In general, they look to sources other than a premium price for profits from cleaning coal.

The most important of these sources of profit is steadier markets. The public wants a clean coal. As each year goes by, more and more of the large consumers buy coal on a basis of B. t. u.'s per dollar and analyze all incoming shipments. The small consumer is also learning to distinguish clean coal. The day is past when he regards coal as something black that supports combustion. He is finding out that first cost per ton is not the only factor in the purchase of coal. He is learning that his family must give much more attention to the fire when the coal is high in ash content, also that he must carry out a large amount of ashes. It is surprising, too, how many people nowadays can tell a piece of shale from a piece of coal. Coal dealers, also, are getting behind the movement for cleaner coal. They want to sell coal that will be satisfactory to their customers and in many cities are doing a great deal to educate the consumer to distinguish between good fuel and poor fuel. Thus, the trend of buying is all in the direction of clean coal.

However, the public not only wants a clean coal; it wants a uniformly clean coal. If a man buys six new shirts, he expects all of them to be made of a uniform grade of material; he expects all of them to be of one size; he expects all of them to have uniformly good workmanship. The coal buyer likewise expects and demands a uniform quality of coal. First, a uniform ash and sulphur content is important. If a coal company ships a few cars of unusually clean coal to some customer, it has educated him to want that kind of coal all the time. If it follows this shipment with some unusually dirty coal, the contrast is particularly bad. Again, uniform sizing and good appearance are often important, especially for domestic trade. One company claims that these are actually more important factors than the percentage of ash or sulphur in the coal. But whether ash, sulphur, size, or appearance is most important, uniformity is a prime requisite for keeping the good will of the public.

The good will of the public is inevitably reflected in the steadiness of the markets. It not only keeps competing coal companies from taking customers—that is one consideration—but it prevents other competing fuels from cutting into the coal business as a whole. Both considerations are important to the maintenance of steady markets. No argument is required on my part to convince any of you that no one thing helps the balance sheet as much as steady markets. This item alone usually more than covers the cost of 20 to 35 cents per ton for the operation of a cleaning plant. This is well demonstrated by the number of large companies that have put in one cleaning plant as an experiment and that have built a number of additional plants. Those companies have quickly found that lower costs with the steadier operation more than compensate for the cost of cleaning.

Another source of profit from cleaning coal is a more complete recovery of coal from underground. The United States Coal Commission † about 10 years ago made an exhaustive study of the losses of coal in mining in the bituminous fields east of the Mississippi. The amount of marketable coal given in its report for "loss in thin or dirty areas or under streams, etc.," is 5.6 percent. Since the commission made this report there has been, in general, a steady improvement in mining methods. However, one well-informed mining engineer tells me that this has been offset in the last few years by the introduction of mechanical loading methods which are not adapted to recovering as much coal from the pillars as could be recovered by systematic hand mining. It is, of course, impossible to say whether this figure of 5.6 percent is now correct, but Sisler's ‡ more recent work for three States indicates that it is probably approximately right on the average. In individual cases it is several times this amount. If a company has a cleaning plant, it can mine many of these dirty areas, thus increasing its recovery of coal. Any working place can be mined at a profit that will yield enough coal to pay the bare cost of mining, of transportation of the coal to the surface, and

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† Report of The United States Coal Commission. 1925.

‡ Sisler, James D. Economic Aspects of Bituminous Coal Losses in Ohio, Pennsylvania, and West Virginia. Am. Inst. Min. Engrs. Coal Division, 1931, pp. 196-205.

of cleaning. In addition, the removal of combustible material from underground in many cases renders the mine safer from fires and gases.

Another source of profit from cleaning coal is a lower mining cost. First, a cleaning plant makes it feasible to use machine loading. During the present economic depression machine loading may not give a lower mining cost than hand loading, but it is in the line of progress and, because of that fact, it is here to stay. Under normal conditions it will prove an economy, and some of the profit should be credited to the cleaning plant.

Second, a cleaning plant obviates the necessity of removing any but large pieces of refuse underground. The mine is a poor place for hand-sorting coal. It costs much more to pick coal in the dark and in a cramped position than it does on a well-designed, well-lighted picking table, and certainly much more than it costs to clean the coal with a modern coal-cleaning system. But, you object, I pay by the ton for mining coal and, even if I change my system of payment to a yardage basis, I must still pay the transportation of all unnecessary rock to the cleaning plant and from there to the refuse pile.

I agree that transportation is a big item around a mine, but when I see men trying to pick out refuse underground, even down to 1-in. size in some mines, I can not but believe the cost of transporting the refuse would be less than the labor cost of the hand sorting. Moreover, there is often a startling percentage of slack coal in the gob piles in mines where a strict inspection system is in force on the tipple. The United States Coal Commission report, previously referred to, gives the "loss in handling and preparation" as averaging 3.9 percent. In many mines this percentage is much higher. I wish I could present a balance sheet having the savings in transportation from hand-sorting underground on one side and on the other side having the savings in labor and in losses in the gob pile from sending all material mined to the surface for cleaning. Unfortunately, I know of no company that has made such a study, for the tendency of most companies when they start to clean coal is to retain as far as practicable close limits on loading rock in the mine. However, I doubt whether it pays to discard in the mine any but coarse pieces of shale, say over 3 in. in size, which can be readily identified. In mines with machine loading even this is probably uneconomical, for the advantages of not attempting to hand-sort coal in the scheduling of the work underground commonly more than compensate for the transportation of refuse to the surface.

In attempting to arrive at a figure representing profits from coal cleaning due to economies in the mine operation, let us ignore the loading machine as a factor and consider only savings in coal. If we add the average figures previously quoted from the report of the United States Coal Commission of 5.6 percent of coal lost in thin and dirty areas and 3.9 percent in handling and preparation underground, we have a total of 9.5 percent. What part of this can the average coal company fairly hope to recover if it installs a cleaning plant? To be conservative, let us assume a little more than one-half or 5 percent. This, on a coal worth $1.50 at the mine, amounts to 7½ cents per ton, of which 3 to 4 cents may be considered profit. On the average this is not a large item, but in individual cases it is several times this amount, often sufficient to pay the entire operating costs of a tipple and washery.

How to Make the Cleaning Operation Economical

There are several elements that enter into the economics of the cleaning operation. First, there is the direct cost per ton of operating the cleaning plant. This, including capital charges, runs from 20 to 35 cents per ton for bituminous coal. Of this amount the cleaning operation itself, segregated from the cost of conveying, of screening, etc., runs 5 to 15 cents. Second, there is the cost of the coal lost to the refuse pile. Third, there is the cost of regaining business lost owing to a poorly prepared product. We are all too prone to take into account only the first of these elements. In this part of this paper I shall discuss some ways of keeping all three elements as low as practicable.

The first way to make the cleaning operation economical is to get the right process for the particular coal. There are all sorts of coal-cleaning problems, and generally some one process is better suited to the operator's needs than any other. Some coals present very simple cleaning problems and an elaborate and expensive cleaning system would be a very unwise investment. On the other hand, if an operator has a difficult cleaning problem, an inefficient cleaning system is a very poor investment.

The first thing to be considered in choosing a process is the difficulty of the problem of cleaning the coal. This involves making a complete set of float-and-sink and screen-sizing tests on a representative sample of the coal. After these have been made, several methods may be used for interpreting the results. One reliable method is to draw specific-gravity distribution curves.§ Little experience is required to use such curves and one is not apt to make some important mistake in determining the difficulty of his washing problem with their use. Anyone can add a ± 0.10 specific-gravity distribution curve to a standard set of washability curves in 15 or 20 minutes.

A study of this curve generally limits the operator to a certain group of processes. After he has thus limited himself, he should next consider special problems, such as flaky impurities, a clay that disintegrates readily in water, or excessively dirty fine sizes, in picking the processes to be used. A study of these may limit still further the choice of processes.

First cost is also an item to be considered in choosing a cleaning process, but it is not as important as one might think. The coal-cleaning equipment itself usually constitutes only about one-third of the cost of a plant. The balance is accessory equipment of various kinds, such as structure, lighting, bins, tipple, and screens, all of which are more or less constant for different processes.

A second way to make cleaning an economical operation is to build the cleaning plant well. This does not necessarily mean a steel or a concrete structure. One or two of the most efficient plants in the country are of wooden construction. I have in mind items such as good arrangement of the plant, ample storage capacity, ample washer capacity, and the like. I wish to stress these items and some others that are commonly neglected in plant design, but which play a very important role in the final results obtained.

Good arrangement of plant is a matter of first importance. I believe plants that are built now will require a number of changes and additions within the next few years. Of the processes now on the market, none has even approached its possibilities. All of them can be greatly improved by fundamental work. And then there will be certain new processes. For example, flotation is more or less of an experiment thus far in coal cleaning. Within a few years I believe many companies will find it economical to clean the natural fines. Any plant built today to prepare a coking coal should include space for this equipment, even though there is no immediate prospect of its being installed. Again, market conditions will change. An operator now selling coal for steam-raising purposes may wish later to sell coal for coke making. If a plant is well arranged, he can add more washing units with a minimum of expense. Sometimes it requires some juggling and work to leave room for expansion, but it is certainly a wise investment of time. The operator can also provide to a certain extent for changes that can not be anticipated by not crowding his equipment too much.

Ample raw coal storage capacity is another matter of importance. Every mine has peak hours. If washer capacity is installed sufficient to take care of these, it will be greatly in excess of the average requirements of the mine. The best method of handling peak loads, both in first cost and in uniformity of operating results, is to install ample storage ahead of the cleaning units. I know of several cases where market conditions have changed and a cleaner coal has become necessary and where the companies have met the problem simply by running the washing units for longer hours. This was possible because the companies originally had the foresight to build storage facilities for two or three hours' supply of raw coal.

Ample capacity in the cleaning units is another item of importance. As I mentioned before in this paper, the cost of the cleaning units themselves constitutes only about one-third that of the plant. As a general principle, it is well to underload cleaning equipment. The savings in losses of coal alone will usually pay many times for the additional cost of excess capacity. Practically every cleaning device does better work at less than normal load. The only exception I know of is the coal-washing table. Its maximum efficiency does not necessarily occur at a low tonnage.

A general principle of cleaning-plant design, which is also of importance, is to build a more efficient plant than necessary for immediate needs. If a company requires a 6 percent ash coal and a given layout will just barely give a coal of that analysis, it may not serve the company's needs six months after it is built.

§ Bird, B. M. Interpretation of Float-and-Sink Data. Proc. Second International Conference on Bituminous Coal. 1928, Vol. 2, pp. 82-111.
Bird, B. M. Interpretation of Float-and-Sink Data. Proc. Third International Conference on Bituminous Coal. 1931, Vol. 2, pp. 721-735.
Reprints upon application to Battelle Memorial Institute, Columbus, Ohio.

Good design requires at least some margin of safety. A corollary to this principle is that a plant should be so arranged, at least for most coals, so that the operator can crush and retreat middlings from the cleaning units in case that later becomes necessary with changes in market conditions. This equipment does not necessarily need to be installed when the plant is built. The point is simply to figure out where it can be installed economically if the occasion arises.

A third way to make cleaning economical is to operate the plant well. I mentioned at the beginning of this discussion two elements in the economics of the cleaning operation that are not often considered; i. e., losses of coal to the refuse pile and losses of business due to poor preparation of the coal. The operating methods have a very important bearing on these two elements. I have actually found a plant where the direct cost of washing was around 20 cents per ton and the indirect cost from losses of recoverable coal alone proved upon investigation to be nearly 50 cents per ton. The latter was directly traceable to poor adjustment of the washers. This is an unusual case, but there is some loss of recoverable coal in every plant, and the reduction of that loss is a way of making the cleaning more profitable. However, I believe in most cases that the largest extra cost comes from a poorly prepared product. This cost is less tangible than the others, and hence is more apt to be overlooked. It goes into advertising and the like and is not traced to poor preparation methods.

One suggestion for good operation is to know your recovery of coal. I use "recovery" here in the special sense that the metal miner uses it. He weighs and analyzes his raw ore and finds how much valuable metal he mines. He also weighs and analyzes his concentrates and calculates the percentage recovery of this metal. The coal operator should do this same thing for his coal. If he ships a 6 percent ash coal, he should know how much 6 percent ash coal he could have recovered with the same degree of crushing, as shown by float-and-sink tests. It may surprise you to know that this determination is rarely made. Operators who have every item of cost figured to a fraction of a cent often do not know within 5 or 10 percent their true recovery. Very often they do not know their true yields of washed coal with corrections for differences in moisture content between raw and washed coal.

In speaking of "loss" of coal earlier in this paper I had in mind the difference between the "recovery" and 100 percent. This is the true loss in the cleaning operation. I speak of this because some companies charge the cleaning plant with all the reject, whether coal or refuse, on the theory that if the raw coal is shipped they are paid for refuse as well as the coal. This is an erroneous method of arriving at the total cost of cleaning. Only such part of the refuse as is equivalent in grade to the coal shipped is really a loss. From an economical standpoint no company really gets paid for refuse; its coal simply commands a lower price per ton than clean coal. Thus the total reject is not a correct charge against the cleaning plant.

Another suggestion for good operation is to employ skilled men to run the cleaning apparatus. The practice is all too prevalent of starting boys on the cleaning apparatus and of paying such poor wages that as soon as they have an opportunity they graduate to the picking table or become miners. Anyone who is capable enough to run coal-cleaning apparatus ought certainly to be worth as much to a company as a good contract miner, for there is no single place around a coal mine where there is as large an opportunity to lose profits for the company as on the coal-cleaning apparatus. It takes brains, experience, and attention to business to operate every cleaning device on the market.

A further suggestion for good operation of a cleaning plant is to keep trying to make improvements. After a company has purchased a cleaning plant of some approved design, it is by no means time to sit back and rest content. There is always opportunity for improvement. I wish that I might somehow bring home to each operator the opportunity for increased profits from the study of coal cleaning. Several men in charge of coal-cleaning departments of large companies have done excellent work in bettering the performances of their plants. Although these men in most cases had excellent cleaning plants that were doing good work, they were not satisfied; they wanted them to be better. When they could not make the separation of coal and refuse better, they found ways to cut the operating costs. The chief engineers of several other large companies have also done excellent work in improving the results obtained in the cleaning plants under their supervision.

However, not all improvements have been made by men specialized in coal cleaning. The president of one coal company has found it profitable to spend considerable time in his coal-washing plant. This man has worked wonders, both by his personal efforts and by inspiring his men to constant alertness for opportunities to do better work. In a number of cases the washery superintendent is the key man who has been making the progress. One of the best coal-cleaning plants in the country has become such largely through the study and work of the washery superintendent. The management that can inspire a capable superintendent to put forth his best efforts and that will back him up in worth-while suggestions for improvements will surely profit by so doing.

I might go on thus with a great number of other details about the operation of coal-cleaning plants, but time does not permit. My thought in what I have said is to start each operator looking for increased profits in his cleaning plant. Anyone who looks carefully will find them in saving coal, in cutting operating costs, or in producing a better and a more uniform product that will better satisfy his customers.

Conclusion

Companies mining and using their own coals, such as the Steel Corporation, receive a premium for a cleaned coal in the form of a better fuel, but only in exceptional cases can companies selling on the open market hope to do so. The latter should look to other sources for profit from coal cleaning, such as steadier markets, lower mining costs, and a more complete recovery of coal from the mine.

Most companies do not obtain the most economical operation from their coal-cleaning plants. They watch the direct cost of cleaning closely, but they fail to take account of unnecessary losses of coal or of loss of business due to a poorly prepared product. Study and work will bring about marked improvements in the efficiency of cleaning plants or, if that is already high, will reduce the cost of operation.

CHAS. W. CONNOR—*The American Rolling Mill Co.*

IN my discussion of Mr. Bird's excellent paper I shall endeavor to present only the viewpoint and experience of a company operating a captive property; that is, one which uses in its own plants the product of its own mines. However, I feel impelled to say, in the light of our own experience, that any operator, captive or commercial, who will follow the course charted by Mr. Bird can not fail to benefit through the opportunity for economies which he has pointed out.

The necessity for installing a coal-cleaning plant at the Nellis mine of the American Rolling Mill Company became evident after the mine had been in operation about seven years. In the selection of its coal properties the company was guided primarily by its need of a special-purpose coal for use in gas producers. Such a coal was found in the No. 2 gas seam in Boone County, W. Va. This coal was also a good steam and domestic coal. In the beginning of operations the seam was fairly regular in height, comparatively free from partings, and the roof was ordinarily good. As development proceeded, however, these natural conditions began to change. Partings began to appear, the character of the roof became worse, and draw-slate became common. No two sections of the mine presented the same conditions in regard to height of seam, thickness and type of partings, nature of roof, or quality of coal. Coal loaded in railroad cars from one section of the mine might show on analysis as little as 6 percent ash, while the next car from another section might run up to 16 percent ash. The greatest concentration of impurities occurred in the 4-in. x 0-in. sizes, which was, of course, the most difficult to clean by hand. It soon became evident that, in spite of the inherent high quality of the coal, its full value would not be realized unless some method of preparation, other than hand picking, were installed.

Every consuming department of our mills was complaining bitterly of the lack of uniformity in the product. Extra expense was being incurred in maintaining proper firebed conditions in gas producers. Fusion point of ash was lowered with consequent additional cost in producers and boilers. Excess boiler capacity had to be carried in order to take care of peak loads. Grates and drafts required constant adjustment. Finally, objection was registered to paying fuel prices for bone and slate as well as to paying the freight on these impurities.

With this clamor for clean coal in our ears, we did everything possible with the equipment available to improve the quality of the product, but our best was not

sufficient, and we concluded that our only hope for betterment lay in some method of mechanical cleaning. Fortunately for us, we made haste slowly and spent some 18 months in inspecting outstanding plants of various types in the eastern coal fields. We shipped several cars of our coal to operating plants for test purposes. Complete washability studies were made and carefully considered. At the conclusion of our investigations we decided that the Rheolaveur system was the type of washer best suited to our particular coal. The plant was installed in 1929, and, after the troubles usually encountered in making necessary adjustments in a new plant, has been in successful operation since that time.

During the time this plant has been in operation we have learned many things about coal cleaning and coal-cleaning plants. We have learned the importance of many of the things Mr. Bird has emphasized with reference to making the cleaning plant economical. Let me reiterate his admonition that you be sure to get the right process for your particular coal. Do not buy a cleaning plant because your neighbor happens to have one of a certain type that works well for him. It may prove a costly "white elephant" for you. Take plenty of time to investigate before making your decision.

When you have made your decision as to the type of plant, next make certain that your building is properly designed and the machinery well arranged. Too many operators try to economize on the cost of the building and cramp themselves for space. Allow for plenty of room. Machinery crowded into a building that is too small will make a plant inefficient, costly to operate, difficult to maintain and repair, and one that is usually dirty and unsightly.

I thoroughly agree in the recommendation that ample storage capacity should be provided. One of the mistakes we made at Nellis was in not having larger bins. Frequently when mine delays occur our bins run empty and, as the machinery must be kept running, there is an uncompensated cost for power, as well as a variation in the product loaded in the railroad cars. On the other hand, when the mine is running at its peak the bins become full and the tipple must stop dumping coal, and again there is a variation in product.

I am also in agreement with Mr. Bird's warning in regard to ample washer capacity. It should be remembered that the cleaning plant is in operation usually only six hours out of the eight during the day, and washer capacity should be predicated on the lower figure rather than on the higher. Provision should also be made to take care of future expansion and increased output.

Most valuable of all perhaps is the suggestion that competent supervision and skillful operators are essential. I do not wholly agree that an operator should be paid as much for his work as a good contract miner, but the duties of an operator vary greatly in different types of cleaning plants, and we may be thinking of different types of men. At any rate, we do not find it necessary to pay our operators such high wages, and yet I think we get just as good results. In my opinion, a good superintendent or foreman who knows his job and who is interested enough to want to improve his plant, his product, and his cost will usually see that the operators get the results expected of them. The keeping of operating records and statistics, analyses, and reports should certainly be required of every washer superintendent.

Referring now to the direct cost of operating the plant, it seems to me there is a tendency to place the cost of cleaning at too high a figure. This practice is indulged in not only by writers on the subject but by representatives of cleaning systems as well. When you tell an operator in these times that it will cost him 25 cents to 40 cents per ton to clean his coal it is easy to understand why there are few cleaning plants being installed. I realize that there may be some plants where circumstances, such as extremely difficult cleaning propositions, locations with unusually high investment, high power or water costs, may cause the actual cost to reach such figures, but on the average they appear to me to be unduly inflated.

In our Nellis plant for the period January 1, 1930, to April 1, 1932, with a production of 653,641 tons and washing 73 percent of the product, or 477,160 tons, we were able to operate at a cost per ton produced of 7.94 cents and per ton washed of 10.88 cents.

This figure included operating labor, repair labor, operating supplies, maintenance materials, electric power, depreciation, taxes, and interest on investment. During a period of normal business I would anticipate a considerable reduction in these costs.

The possibility of securing business from a new or unexpected source through the cleaning of coal has been mentioned by Mr. Bird. An illustration of this may be given from our own experience. When we installed our washer we had no idea of supplying anyone but our own plants with washed coal. Our ash content in the product going to the washer was 13.55 percent. We contemplated giving our plants a 7 percent ash coal. Later, through adjustments and improvements, most of which we devised ourselves, we were able to get a product averaging 6.1 percent ash. Then we began to think of getting into the by-product market. Tests were made which proved successful and orders were secured which resulted in increasing our output and working time by approximately 55 percent. This, too, at a time when working time was a big factor in keeping our organization together. Later still we were able to reduce the ash content to an average of 5.31 percent. I do not have immediately available figures to show what this meant in decreased cost, but it would certainly be very conservative to estimate the savings at 15 cents per ton.

Another source of savings to our company was in the improved quality of coal shipped to the boiler plants and the savings in freight charges. For the period July 1, 1930, to January 1, 1932, we shipped to two of our plants 142,871 tons of boiler coal. Due to the decrease in ash content, and allowing for added moisture (.87 percent), we were able to save $17,423.53 in freight charges alone. The coal cost saved, which means the impurities that were removed and which the plants would have paid for at the fuel price before the washery was installed, amounted to $15,831.37. The total saving on these two items amounted to $33,254.90, or 23.3 cents per ton of coal used.

I make no estimate of savings in coal used in producers, since during the period on which comparisons must be based the accounting system was reconstructed, numerous economies in operating and maintenance labor were made forced by exigencies of the present economic situation, and operating schedules were such that reliable comparisons are difficult to arrive at. There is no question but that a substantial saving was really effected. However, no estimate will be included here.

You will have already perceived that the opportunity for greatest savings is afforded the consuming units rather than the producing units. This will probably always be true in the case of captive mines. The commercial shipper should, however, be able to participate to a greater extent in the possible savings accruing from coal-cleaning economies as the consumer-customer becomes better educated in the advantages of clean coal and is willing to pay an increased price for a better product. Small savings are sometimes possible at mines where a considerable force is employed on picking tables. When the washer was installed at Nellis we were able to eliminate eight slate pickers, at an annual saving of $5,032.60, or 1.73 cents per ton. Under existing conditions the average commercial operator can not hope to obtain a premium price for washed coal that will reimburse him for his cleaning cost. Nevertheless the opportunity is open for savings in cost of production through improvement in quality, wider markets, increased production, and better working time.

Summarizing briefly, we have found our cleaning plant to be a profitable proposition. We have been able to give our consuming departments a fuel of high quality. We have reduced the ash content of our coal from 13.55 percent to 6 percent, and less where desirable. Sulphur has been reduced from .97 percent to .80 percent. Fusion point of ash has been raised 150 degrees to 250 degrees in the various grades shipped. The B. t. u. values have been materially improved. Added moisture content has amounted to only .87 percent. Gas yield is bettered. The product is uniform and complaints are practically nonexistent.

Our absolute savings in dollars and cents (not including probable savings in producer coal) have amounted to $67,563.80 per annum, or 40 cents per ton. If from this we deduct the annual cost of washing amounting to $23,094.13, or 10.9 cents per ton, the cleaning of our coal has cost us nothing, and we still show a clear profit of $44,469.67, or 29.1 cents per ton washed. If this saving is applied to the retirement of the investment, the plant would, at this rate, pay for itself in less than four years. If such results can be shown during a period of depressed business conditions, surely it is reasonable to expect that savings would be much greater during times of normal operation.

We feel, therefore, that our venture in coal washing has proven both successful and profitable.

K. A. SPENCER—*Pittsburg & Midway Coal Mining Co.*

THE Pittsburg & Midway Coal Mining Company, like other coal-mining companies in the country, in the past trying years has endeavored to develop some means of reducing mining costs and increasing earnings. After consideration, we arrived at the inevitable conclusion—every effort must be exercised to maintain mine realization and increase tonnage. In the case of strip mines, tonnage per unit is the largest controlling factor of mining costs. We therefore concluded to install large excavating and loading units, in the pit, with the idea of concentrating the loading without much regard to preparation or cleanliness of the coal, transporting the coal as cheaply as possible in 35-ton drop-bottom cars, and dumping it all into one preparation plant and concentrate on cleaning and preparation at this point. This policy was decided upon and put into practice.

This plan, however, meant that the sizes which were too small to economically hand pick must be cleaned mechanically. We therefore set out to find a cleaning process best adapted to Kansas coal, which is inherently dirty, on account of horsebacks or clay slips, so prevalent in Kansas coal. After a quite thorough investigation, we decided upon the Wuensch differential density process which at that time was undeveloped, to solve our problem and, at our No. 10 mine near Pittsburg, Kans., we installed the first unit, with the idea of making of it a pilot plant to prove or disprove the merits of this system. The plant was completed in August of 1931, designed to only handle 30 tons per hour. Since that time, however, by increasing the capacity of coal-handling equipment, the plant is now washing 600 to 800 tons per day most satisfactorily, and we are now building a 300-ton per hour unit for our mine No. 15, incorporating all of the refinements developed in the original pilot plant.

The Wuensch process depends on the old principle of using a heavy density medium to float the coal while the refuse sinks through the medium and is rejected at the bottom of the separator. In the Wuensch process the heavy medium is accumulated from the natural slimes of the coal, consisting of fire clay, shale, and pyrite. This material is extremely fine in size and actually approaches the characteristics of a collodial solution. Although such a fine heavy medium had been used many years ago for the cleaning of coal, the Wuensch process uses new methods of control and operation to increase the effectiveness and simplify the apparatus. The medium is circulated and middlings from the coal are accumulated in a cone-shaped separator to form a column, which gradually diminishes in density from the bottom to the top. This "differential density" is the distinguishing feature of the Wuensch process which enables it to create conditions which are even more effective than can be obtained by solutions of uniform density. The lower top gravity allows the fine refuse particles to settle rapidly out of the feed so that they will not be carried from the separator with the coal discharge. The heavy bottom density prevents good coal from passing out of the machine with the refuse. With the "differential density" feature the specific gravity in the incoming medium need not be maintained at an accurate point, as the separation takes place at some critical point between the lightest gravity at the top, which is lighter than the lightest particle and the heaviest gravity at the bottom, which is nearly as heavy as the heaviest particle.

The flow sheet is briefly as follows: The raw-coal hopper is filled with 1¼-in. slack either from the tipple by a conveyor or by a conveyor from an unloading station. From this hopper coal feeds directly into a cone, which separates the clean coal from the slate down to an extremely fine size. The coal passes from the cone to a dewatering screen, the first section of which is used to remove the medium, and pass it to Sirg tank, from which it circulates by means of a Wilfrey pump immediately back to the top of the cone. As the coal advances on the dewatering screen, it is sprayed with water to remove the medium, which in its diluted condition is passed to a 20-ft. thickener, which is used to thicken the medium back to the proper heavy gravity.

The medium from the thickener is pumped, with a diaphragm pump, to a point where it may be introduced into the bottom of the cone as a heavy density medium. The amount of this medium in circulation is controlled by a by-pass so that the proper amount of medium is introduced into the bottom of the cone at all times. A small classifier is used in connection with the wash water from the dewatering screen to remove the granular particles of coal from the water which is to be sent to the thickener. The purpose of this classifier is to insure that the medium shall contain nothing but fine slimes. On the refuse side of the cone is a scraper wheel, which serves the double purpose of elevating the refuse from the bottom of the cone to the point of discharge and receiving the heavy medium and keeping it in suspension by its rotary motion. From the point of delivery at the top of the scraper wheel the refuse passes to a gravity screen on which the medium is sprayed off the refuse. Under this screen is placed a second classifier to remove the granular refuse products and return the slimes to the thickener.

The results of this plant indicate this washer is under control at any predetermined specific gravity at which it is desired to make the separation.

Performance of the washery is indicated by the analysis of the raw and washed 1¼-in. screenings, last month, on one test, 24 cars of washed coal, compared with 18 cars of raw coal all loaded the same day, analyzed as follows:

	As received	
	Raw	Washed
Moisture	6.8	7.1
Ash	16.2	6.8
B. t. u.	11,220	12,640
Noncombustibles	...	70

The above comparative analysis indicates that with the original plant we are getting very satisfactory results. In fact, we are elated with the performance of this plant and are looking forward with much interest to future refinements, which are being developed in the new 300-ton per hour plant for our Mine No. 15.

JOS. PURSGLOVE, JR.—*Pittsburgh Terminal Coal Corp.*

THE No. 8 cleaning plant of the Pittsburgh Terminal Coal Corporation, at Coverdale, Pa., was put into operation on January 21, 1931, and has been operating almost continuously since that date. Thus the company has experienced a 14-month period of marketing a low-ash, slate-free, high-fusion, Chance cleaned coal in comparison to their other operations immediately adjacent to the No. 8 mine, which ships a hand-picked coal that, prior to the installation of the No. 8 cleaning plant, analyzed much better in every respect than the former No. 8 hand-picked coal.

When the decision was made to install a cleaning plant of the Chance sand flotation type, it was based upon the experience of many operators of plants of this design. Their success in the performance of their respective plants left no shadow of doubt as to the success which the Pittsburgh Terminal Coal Corpoartion would have with a plant using the same process.

Preliminary float-and-sink tests made on the No. 8 mine coal definitely indicated the ash and sulphur reductions, and the percentage of reject which would be affected by cleaning in a Chance cone. It was possible to set up approximate costs of cleaning from reliable data secured in the operation of Chance plants over a large number of years. In short, the operating results, and costs of the No. 8 plant were definitely known before the plant was built, but the one equally, if not more important factor: marketing conditions, was not so definitely known, because of the relatively small percentage of mechanically cleaned Pittsburgh bed coal going to market, and the lack of reliable data on that cleaned coal which was sold.

The fact that a plant costing several thousands of dollars was being built, and that the major factor involved in its construction was apparently quite unknown, seemed to be a distinctly radical move, if not a gamble. I determined to investigate the marketing of the cleaned coal, and to set up in the future some concrete figures which would indicate what the company could continue to expect from its No. 8 mine, after the washery that I was building had been in operation. No one connected with the future sale of this coal, nor disinterested parties familiar with coal marketing, would make a single definite statement as to whether or not the mine would experience increased working time, or would enjoy an increase in realization, comparable to the increase in efficiency of the coal.

Of course, the depressed state of affairs in the coal market generally makes anyone reluctant to state anything in very definite terms, particularly that the realization or working time will increase tions—as positive in the minds of everyone as the knowledge of plant operating costs and cleaning results, when a cleaning plant is contemplated for any given mine.

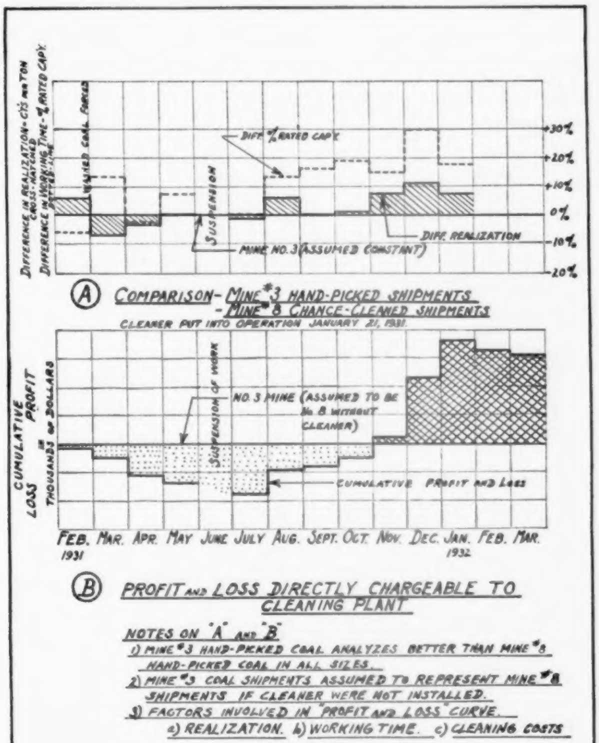

FIGURE I

in any case. The fact that I could not understand, however, was that here was a coal that was about to be improved 100 percent in appearance, 10 percent in thermal properties, 200 degrees in fusion, and 50 to 100 percent in uniformity, and yet, in view of all these potent sales points, one could not definitely say that the mine will have increased working time and realization, or will at least enjoy one of these possibilities.

It is an extremely difficult problem to get a fair comparison upon which to base one's calculations in dollars and cents in attempting to determine whether or not the cleaning of a given coal is actually justified, even after the plant has been installed and running for a long period of time. Ever changing prices paid for coal, and many other variable factors are necessarily involved in the marketing of any coal. It is possible, however, to analyze all the factors, and to form from this analysis concrete figures which show indisputably the worth of coal cleaning to any particular company.

Our investigations have proven to us that the cleaning of coal at Mine No. 8 is a definitely profitable operation, and the bulk of the discussion in this paper will be confined to an explanation of the graphs in Figure 1, which show diagrammatically the complete story of the economics in the No. 8 case. Graphs of this general type, made up from the experience of several cleaning plants, should make the dubious factor in cleaner installations—that is, marketing condi-

Discussion of Graphs in Figure 1

It is possible to compare the tonnages of past years with the annual tonnages produced after the installation of a cleaning plant. It is, however, absolutely impossible to compare the realization per ton shipped from a cleaning plant mine of today with the price paid per ton of hand-picked coal a year or two ago from the same mine. This is brought about, of course, by the continuous decline in coal prices, and it is anyone's guess what a certain mechanically cleaned coal would be selling for if it were only hand-picked at present as in past years.

For the above reasons, the graphs in Figure 1 are made up on the basis of a comparison of the current prices paid for hand-picked and cleaned coals, and a similar comparison of the amount of working time between two adjacent mines.

Mine No. 3 of the Pittsburgh Terminal Coal Corporation operates in the same seam of coal, and adjoins the No. 8 mine underground, but due to a local variation in the coal bed in this vicinity, No. 3 mine raw coal has always been somewhat lower in sulphur, and approximately 0.75 percent lower in ash in all sizes than No. 8 mine's raw coal. For this reason, prior to the installation of the No. 8 cleaner, Mine No. 3 always had preference over No. 8. All orders which could be loaded at either one of the two mines were naturally given to No. 8, because of the fact that No. 3 had many more orders which specified Mine No. 3 only.

The result was that No. 8 was favored with all optional orders, while No. 3 had to stand on its own feet in the market. Coal from both mines, when both were hand-picked, went into the same general district of consumption, and for that reason, along with the others listed above, it is a perfectly fair comparison to assume that the working time and realization experienced over the last year by Mine No. 3 represents what one would expect at No. 8 mine if the cleaning plant were not in existence.

This comparison gives very conservative results as far as the cleaning plant case is concerned, because No. 3 mine is now given all optional orders, and is favored generally, while No. 8 is required to find new markets to offset the business taken from it in the way of optional loadings. Mine No. 3 also has a retail yard in connection with its tipple which helps its production materially several months in the year. Mine No. 8 loads 5,000 tons per day which the sales department must dispose of, while Mine No. 3 loads 1,800 tons; so the market is continually being pushed with No. 8 cleaned coal, while the pressure from No. 3's 1,800 hand-picked tons is not nearly as great. One can not calculate the actual dollars and cents involved in these latter factors, of relative market pressures behind each coal, changing of optional orders, retail yard help to No. 3 production, etc.; but to neglect their presence would be a serious omission in any such analysis.

Graph "A" shows the comparison of No. 8 cleaned coal with the hand-picked coal of No. 3 over the 14 consecutive months immediately following the installation of the cleaning plant. One can assume in studying the graph that the straight horizontal line represents the present No. 8 operation if the cleaning plant had not been installed. The heavy line in the graph, the area under which is cross-hatched, represents the difference in selling price between No. 8 cleaned coal and No. 8 hand-picked coal, or in reality No. 3 hand-picked coal. When this full heavy line is below the horizontal line, it means that the No. 8 cleaned coal is sold for less than the No. 3 coal for that particular month; if the line is above the No. 3 horizontal, it means that the washed coal was sold for more than the hand-picked coal for that month.

The difference in selling price, however, has no great significance without some corresponding knowledge as to the relative proportion of working time experienced at any given price. For this reason, I have also shown on Graph "A" a dotted line which shows the difference in percentage of working time between No. 8 and No. 3. When the dotted line is below the horizontal, No. 8 is working less with cleaned coal than it would be working with hand-picked coal, and when it is above the line, the opposite is the case.

Over the 11-month operating period shown it is to be noted that the coal was sold at a premium over hand-picked coal for six months out of the 11; at the same price for two months; and the remaining three months at a lower price. It must be pointed out, however, that those months during which the washed coal was sold for less than hand-picked coal were the first few months that the washery operated, thus indicating that the

coal was being forced on a market unacquainted with its new properties. During 8 of the 11 months the washery operated a greater percentage of the available working time than did the hand-cleaning mine at No. 3. Two of the 11 it worked less than No. 3, and one month they both worked equally. It is interesting to note that, as one would expect approximately six months of cleaning-plant operation elapsed before the coal market actually began to appreciate the washed coal. This is shown by the fact that after six months time not only did the working time increase materially over hand-picked production but so also did the price.

One of the most interesting aspects of the entire Graph "A" is the combination of realization and working time differences during the month of December, 1931. During this month the cleaned coal commanded 30 percent more market than the hand-picked coal, and at the same time this much greater percentage of production was sold at the highest premium price of the entire year. This indicates clearly that the cleaned coal is moving to an entirely different group of consumers whose demands for cleaned coal change entirely independently of the varying demands of the hand-picked coal consumer. In other words, No. 8 cleaned coal has entered markets from which it was completely excluded as a hand-picked coal, and thus Graph "A" in Figure 1 answers two very predominant questions in coal-cleaning investigation, to wit: Does the cleaning of a given coal permit it to enter new markets and at the same time secure preference in its former markets, thus creating a greater percentage of working time; and is the consumer in the new and former markets willing to pay more for cleaned coal?

Graph "A," in Figure 1, is not completed for the months of February and March, 1932, as the data covering the operations of Mines No. 8 and No. 3 is not sufficiently representative to warrant deductions therefrom.

On examination of Graph "A," in Figure 1, one is promptly confronted with the question of how much this additional or lower price, with its corresponding difference in percentage of working time, is worth to the mine owner when cleaning costs, and the additional reject loss is taken into consideration. Graph "B," in Figure 1, answers the above question, as the cumulative profit and loss curve shown therein is the interpretation in dollars and cents of the actual worth of the No. 8 cleaning plant. As in the case of Graph "A," this curve is made up on the basis of a comparison with the operation of Mine No. 3. In determining the comparative profit or loss of washery operation for each month, the following factors were taken into consideration: (1) The difference in selling price; (2) the reduction or increase in fixed charges on the entire No. 8 mine, brought about by the difference in percentage of working time; (3) the total cost of cleaning coal, including the increased percentage of reject.

The curve, as plotted, represents the total profit or loss of the Pittsburgh Terminal Coal Corporation in the cleaner operation to date for any particular month. The profits from operations of the period August, 1931-November, 1931, inclusive, were more than sufficient to offset the losses suffered in the first five months of operation when the cleaner was commencing to get under way. The cross-hatched area from November, 1931, through March, 1932, shows clearly that the washery has a good substantial profit to its credit up to the present time.

Conclusions drawn from Graph "A" might be applied to the experience to be expected from the same cleaning plant using several commercial processes provided each process considered could produce a cleaned coal of equal qualities. It is perfectly logical to assume that the market would react the same in all cases to a cleaned coal of equal properties, regardless of the process used in accomplishing its improvement. Conclusions drawn from Graph "B," however, can not be so generally applied as the total costs of cleaning a given coal to a certain ash and sulphur content by several different processes may vary greatly, and although the marketing advantages of the cleaned coal as shown by Graph "A" are great, when Graph "B" is plotted, taking cleaning costs and increased reject losses into consideration, the cleaning operation as a whole may show a substantial and continual loss.

Assuming that the market will react favorably to a given coal cleaned to a predetermined ash and sulphur content, the economics of coal-cleaning plant installation is immediately resolved to the question of which commercial process will clean the coal in question to the desired ash and sulphur content at the lowest over-all cleaning cost and with a minimum of reject loss. The advantages afforded by the increased marketability of the cleaned coal will, in any case, not be so great that these costs could be overlooked, because the higher the cleaning costs, the higher the over-all cleaning-plant realization must be before the operation is profitable. The market will stand for only one definite difference between a given hand-picked coal and the same coal cleaned to a certain ash and sulphur content, and it is within these limits that the successful cleaning-plant operator must work.

The Powhatan Cleaning Plant of the Powhatan Mining Company

The Powhatan cleaning plant has had more than a six-month operating period, having been put into operation on September 21, 1931. The Powhatan mine is located about 20 miles south of Wheeling, W. Va., on the Ohio River, at Powhatan Point, Ohio. It is the southernmost mine which ships coal from the eastern Ohio No. 8 Pittsburgh seam, and its coal is similar to that of all other eastern Ohio mines except that it is higher in ash and sulphur and all prepared sizes in the raw or hand-picked state. After the installation of the cleaning plant the washed shipped coal is lower in both ash and sulphur than practically all other mines in the district.

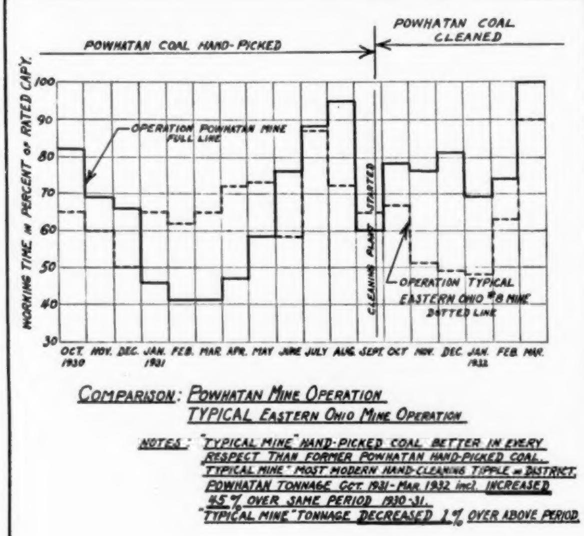

FIGURE II

Discussion of Graph in Figure II

The graph in Figure II shows the operation of the Powhatan mine over an 18-month period as compared to the operation of another typical hand-picking mine in the same district. In studying the graph the following factors should be carefully considered when comparing the two operations: (1) The typical mine ships a hand-picked coal considerably lower in ash and sulphur than the former Powhatan hand-picked coal; (2) the typical mine shown has one of the most modern hand-picking tipples in the State of Ohio; (3) the typical mine over a period of years has generally worked about the same percentage of working time as the eastern Ohio No. 8 district as a whole; (4) the Powhatan tonnage over the first six-month period that the washery operated increased 45 percent over the same period of the preceding year; the tonnage of the typical mine decreased 1 percent over the same period; and the coal business as a whole decreased in tonnage over 20 percent during the same periods.

The similarity between this comparison in Figure II and the comparison in Graph "A," Figure I, is striking in that the mine with the washery operates a much

greater percentage of the available working time in both cases, even though the Pittsburgh and eastern Ohio districts have entirely different territories of consumption.

I have no figures with which I could construct a realization curve similar to the one in Graph "A," in Figure I, and then in turn a "profit and loss" curve similar to the one in Graph "B," in Figure I, but I am confident that if I were able to make such a graph, that the profit directly attributable to the Powhatan cleaning plant would greatly exceed the profit of the No. 8 plant.

General Conclusion

It is obvious from the graphs in Figures I and II that cleaned coal will find new markets and will continue to hold those markets more firmly which it had as a hand-picking operation. It is also apparent that where such increased demands exists that increased realization is an inevitable result.

It might be well to list at this point some of the consumer's reasons for preferring the No. 8 and Powhatan Chance cleaned coals. The operators of by-product coke plants have been particularly pleased with the consistent uniformity in the low-ash, slate-free No. 8 product. The operators of steam plants have made special mention of the exceptional over-all increase in efficiency obtained in their plants derived from the use of No. 8 and Powhatan cleaned low-ash coals. Small domestic consumers, who buy coal chiefly by appearances, and according to the quantity of ashes handled from the firebox, make mention of the fact that they have not been able to find the slightest trace of free slate in the coal, and have been able to operate their fires over much longer periods of time than when using hand-picked coal without handling any ashes.

When a cleaning plant is contemplated in the future, except in very special cases, I can see no reason for any doubt as to whether or not the operation considered will enjoy increased realization and working time, as proven conclusively by the past experience of many cleaning plants. As mentioned in the first portion of this paper, the dubious factor in the construction of the No. 8 plant was marketing conditions, for the operation of the plant was easily approximated from the past experience of sand flotation plants. With it now possible to closely estimate the marketing conditions to be expected from the records of operating plants, I see no legitimate reason why cleaning-plant installation can not be resolved into as definite an engineering problem as the construction of a bridge, with all factors in the case being known.

L. A. OSBORN—*Bradshaw Coal Co.*

THE homely old adage "Where Ignorance Is Bliss, Tis Folly to Be Wise" was followed by the entire coal-mining industry until a very recent time, and is still being adhered to by many operators, but I am safe in saying that this number is rapidly diminishing and is fast becoming the minority.

The truth of the proverb was proven in the early years, if unlimited markets and profits meant "bliss."

A very short time ago a new profession was created and was christened "efficiency engineering," and it has about wrecked the coal business. The followers of this profession were assigned tasks of discovering and stopping many economic leaks that had gradually crept into the manufacturing industries.

Eventually their thoughts turned to the item of fuel, which, in the early days, meant nothing but coal and coke, and much to their surprise they discovered that in many cases the initial and maintenance cost of the heat-producing units should not be directly chargeable to the power, heat, or products produced. In many cases they found that 33 1/3 percent of these units were being used for the distillation of water and the heating and melting of extraneous matter.

Further examination of their fuels developed that the purchasing department had been buying coals ranging from 2 to 20 percent ash, and from 2 to 15 percent moisture, so they unanimously reported to their companies the discovery of a tremendous economic leak. The thought was an entirely unexpected and unlooked for idea, and at first was by many ignored, but of late is being investigated by practically all large fuel consumers.

The result is that at the present time there is great interest in the cleaning of coal, and mine operators are realizing that the value of standard coals must be increased, or gas, oil, and electricity will continue to encroach upon markets now supplied by them. Good coal, ¾ in. or less in size, when thoroughly cleaned and dried, has no substitute as metallurgical or by-product fuel. The value of this size coal as steam coal when cleaned, dried, powdered, and burned in suspension, or burned without powdering on the latest type of mechanical stokers, is very high.

As this ¾ in. to 0 in. coal from some seams contains a large percentage of dirt and water necessarily mixed with the coal, the failure to clean this coal is largely responsible for its displacement in steam power-producing plants of the country, as well as being largely responsible for gas, oil, and water produced power, supplanting coal produced power. It is now doubtful if fine coal containing as much as 8 percent ash and more than 6 percent water will be knowingly accepted, either as a metallurgical, by-product, or steam coal, particularly where the freight rate is the greater cost.

Where coal is sold on a B. t. u. basis, the water the coal contains when weighed, or at the point of consumption, will be the determining factor, as moisture is as much of a noncombustile as dirt, and the sum of the two would necessarily have to be subtracted from the coal to arrive at its true B. t. u. value.

If coal is to hold its own against the fuels mentioned above, it will necessarily have to be cleaned, and owing to its size and large surface area that will be exposed to water in wet washing, as compared with its weight, it will have to be cleaned dry, or if it is washed it will have to be dried before shipment.

These troublesome and expensive difficulties can be overcome by cleaning the coal dry, and further, when coal is cleaned dry a portion of the water the coal absorbs in mining, as well as the dirt collected, will be removed by one operation while passing through a dry-cleaning separator, with the result that the B. t. u. value of the coal at the scales, or point of consumption, will be increased.

The Bradshaw Coal Company, one of the companies for which I am engineer, operates a drift mine in McDowell County, W. Va., on the Dry Fork Branch of the N. & W. Railway Company, 11 miles south of Iaeger, which is the main-line junction. The seam of coal being mined is known as the "Bradshaw seam" and covers only a relatively small area; in fact, there are only two companies mining this seam of coal. It is an excellent high-grade, low-volatile, semibituminous coal, and averages from 36 to 50 in. in thickness, with a band of friable slate averaging from a knife-edge to 6 in. in thickness, located near the top of the seam.

This company mined and shipped their product in comparative bliss during the years 1918 to the end of 1927. During that time they shipped hand-picked 5-in. lump, hand-picked 2½-in. to 5-in. egg, and a 2½-in. to 0-in. nut and slack, which naturally we did not hand-pick. We, like other companies, made money in good years, and our losses were comparative in bad years. Not many complaints were received on shipments, and if a customer was lost, he was immediately replaced by another one found for us by the Bluefield Coal and Coke Company.

During the latter part of 1927, complaints began to arrive on our 2½-in. to 0-in. nut and slack shipments, and we were fast reaching the end of the list of prospective customers. On casual investigation of the railroad cars with nut and slack shipments, we discovered that there was a considerable visible amount of small pieces of extraneous matter, ranging from ½ in. to 2½ in. in size, and on analyzing the different sizes of the coal from 2½ in. to 0 in., we found that the ash content ran over 20 percent in the ¾-in. to 2½-in. size, and that this size represented approximately 25 percent of the 2½-in. to 0-in. grade. As the ash in the 2½-in. to 0-in. averaged 18 percent, we decided to screen out the coarser sizes and clean them, knowing that by so doing it would also improve the ¾-in. to 0-in. slack.

The directory of the company was, as all other companies, made up of excellent and successful business and professional men, the majority of whom knew not, or did not care to know, about the methods of mining and preparing the coal, but unanimously agreed that the ¾-in.-2½-in. should be cleaned, and cleaning to them meant washing.

As the size in question was not to be marketed for metallurgical, steam, or by-product purposes, and the presence of added moisture was not then to be seriously considered, no controversy was entered into by the practical mining men of the company, as cleaner coal and its salability were the only questions involved.

The company in 1928 installed a Menzie-Hydro separator, and the results as to cleaning the coal were very gratifying, as the ash in the washed ¾-in. to 2½-in. was reduced to 5½ percent, or less. The benefits received from the washing of the nut and stove sizes, as reflected by satisfied customers and money received from the product, more than offset the extra cost of installing a steam heating unit with radiators near

the Hydro separator and in the storage bins for the washed nut and stove coal; also, the cost of a day and night fireman for the heating plant during freezing weather. We are still troubled in cold weather on account of the ice forming in and around the tipple from the water that drains from the bins and railroad cars loaded with the washed product.

Although the percentage of ash in the remaining ¾-in. to 0-in. was reduced from the 18 percent plus that it was in the 2½-in. to 0-in., to an average of 15 percent, it was only a short time until we were losing our customers on this grade of coal, in fact, repeat orders for the slack never appeared. As this size represented 45 percent of the entire tonnage shipped, it became evident that regardless of the practically unlimited demand that we had for the hand-picked lump and egg, which car samples showed an ash content of approximately 2 percent or less, and a washed stove and nut, which car samples showed an ash content of 5½ percent or less, and which sizes were really bringing a premium price in the market, that the company could not mine the coal at a profit by not being able to place any of the slack in any market at any price.

In 1930 the consumption of coal, especially for steam and metallurgical purposes, was rapidly decreasing, the requirements and demands from the consumers, relative to preparation became greater, and as we thought, more unreasonable. We were informed by our sales agents, both by direct statements and by very convincing decreased financial returns, that it was impossible to market any slack containing an ash content such as ours, and that in order to secure a suitable market for this slack, it must be prepared so as to meet the requirements for metallurgical, by-product and steam purposes.

Again this fact was brought to the directors' attention, with the information that not only a clean product was required, but a dry product, with the further information that by analyses and the sink and float tests, we had determined the susceptability of our slack to cleaning, and we found that the float coal at 1.50 specific gravity analyzed less than 5.5 percent ash, with no appreciable loss of coal in the refuse, which proved that the ash content could be reduced to approximately 6 percent.

After a thorough investigation of plants that were mechanically preparing their slack for the above mentioned markets, it was decided to install a pneumatic coal cleaning plant made by the American Coal Cleaning Corporation, of Welch, W. Va.

The total cost of the Menzie Hydro separator installed was approximately $12,000, not including the additional cost of a side track and storage bins for the cleaned stove and nut, and the cost of the American Coal Cleaning Corporation's pneumatic separator was $18,500 for a turnkey job. When the Hydro separator was installed, it required the additional services of an attendant, and when the pneumatic separator was installed this same attendant looked after both cleaners.

The operating cost per ton of coal cleaned by the pneumatic separator is as follows:

Power	.0123
Labor to operate (½ of total)	.0064
Repairs, oil and material	.0018
Depreciation at 10% per annum	.0200
Interest on investment at 6%	.0058
Taxes and insurance at 2%	.0041
Total	.0504

The operating cost per ton for the Hydro separator is approximately the same, but no accurate figures were available. On the basis of tonnages treated by the separators in 1931, the installed cost was $750 per ton-hour for the Hydro, against $370 per ton-hour for the pneumatic.

As previously stated, the hand-picked lump and egg shipments showed 2 percent or less ash content, and after the installation of the Menzie Hydro and the American Coal Cleaning Corporation's pneumatic separator, the shipments of the washed stove and nut and the air cleaned ¾-in. to 0-in. slack showed less than 7 percent ash content.

The company is one of the exceedingly few in the Smokeless Fields of West Virginia that has enjoyed a steady run, in fact, during the years 1929, 1930 and 1931, the company did not lose a day of operating caused by lack of orders. Part of the credit of 100 percent performance should be given our sales agents, the Bluefield Coal and Coke Company, of Bluefield, W. Va., for not only did they furnish orders for a 100 percent run, but obtained a premium price on all our grades other than slack.

The economies and benefits that the company enjoyed from the cleaning of their coal can only be estimated to be the entire value of the plant, for if the cleaners had not been installed, today we would not be in existence, as we would not have been able to place a car of stove, nut or slack on any market. Mr. Frank S. Easley, president of the Bluefield Coal and Coke Company, showed me figures proving that the increased price we obtained for our cleaned slack more than paid for the entire cost of the pneumatic cleaner in the first four months that it operated; and that was several months sooner than we completed our deferred payments to the American Coal Cleaning Corporation.

An ideal coal where the carrying charges are high, as it is from the Pocahontas Field to Chicago ($3.35 per net ton), would be 2 percent combined and uncombined moisture, 6 percent ash, less than 1 percent sulphur, less than .001 percent phosphorous, and volatile content to vary according to the wishes of the customer. This could be established as standard. This quality of coal would probably stand the highest carrying charges and a premium should be paid for coal superior to this. Less pure coal should be used where the carrying charges would be less, and graduated down to the lowest carrying charge, which is about 25 cents per ton.

With the exception of the moisture, which is higher, and the volatile matter which is between 16 and 18 percent, this is about what they are shipping from the dry cleaning plants in the low volatile fields of West Virginia.

Assuming that in 1931 the Bradshaw Coal Company shipped their entire tonnage of 2½-in. to 0-in. coal, averaging 2 percent moisture and 6 percent ash, to a Chicago customer at an average price of $1.50 per ton f. o. b. mines, the customer would have paid to the railroad $392,000 for transportation and $180,000 to the company for the coal. For this amount he would have received 92 percent of pure fuel.

If this customer had obtained this amount of our product at the same price in 1929, the same amounts would have been paid to the railroad and mine operator, but he would have received only 77 percent of pure coal. On the 1931 purchase, a saving of $48,800 for transportation and $26,940 for the fuel, or a total of $85,740 was made, and the coal company would have expended $6,000 in preparing the coal for his customer. I leave it with you, consumer and operator, whether or not the consumer would not have been willing to pay this cost and even an extra bonus to such an intelligent and satisfying operator.

By this elimination of 15 percent of more than useless material, not only a saving of $85,740 accomplished in freight and cost of the coal, but this was only one of the many benefits and savings obtained by the use of a prepared coal, which means a uniform size coal, a uniform clean coal, and a uniform dry coal, for these mean a uniform increase in the quality and quantity of coke produced per hour, or a uniform increase in the heat units produced from a ton of coal.

W. J. SCHENLER—*The Colorado Fuel & Iron Co.*

BENEDICT SHUBART—*Denver, Colorado*

In describing preparation methods of western coal mines, it is difficult to get away from an abecedarian cataloging of the devices used, most of which are as well-known in the East as they are in the West. We can go through the list of car hauls, scales, dumps, weigh baskets, feeders, screens, picking tables, loading booms, degradation screens, magnetic pulleys, boxcar loaders, car retarders, and so on, and every element is familiar to the western operator.

Yet there is a wide difference between a tipple for Illinois or West Virginia and one for many of the Rocky Mountain states. Why this is so is never clear to eastern designers. Often the reasons for the specifications laid down by the western operators are not thoroughly understood by the eastern designers, the westerner is told that those coal preparation plants should be built thus-and-so, and where the eastern designer has been able to overpersuade his client, the results have always been expensive, as well as a permanent handicap, to put it very mildly. This criticism does not apply to certain eastern designers who have taken the trouble to study western conditions, and realize the difference in the problems involved. Several of the larger engineering companies have come West and

lived West long enough to absorb the needs of the territory, and some of our western tipples cannot be surpassed any place in the country for completeness and perfection in meeting the demands of the sales organization.

Let's digress here just a minute to say that any tipple designer who fails to take the sales department into his entire confidence, who fails to consult with them and to listen to them as thoroughly as to the operating department is going to come to grief. Too many engineers, and too many operators too, we are sorry to admit, look upon coal mining and coal preparation as a technical game, losing sight of the fact that the entire reason for the operation of a coal mine is to sell the coal at a profit. Many sales organizations lose sight of that end too, for altogether too frequently a saving in the mining end is used by the sales organization as an excuse for lopping another 25 cents off the price of the coal.

Market conditions and market demands place upon the Rocky Mountain district a complication and a burden which is rarely present in the East. The long hauls to western markets, hauls of almost a thousand miles are not uncommon, the degradation and pilferage on open cars of lump coal under altitude and temperature conditions varying from sea level to 10,000 ft. and from summer to winter in the same trip, have created a demand for the loading of the larger prepared sizes of coal entirely in boxcars, and in many districts, lump coal in open cars is a rarity. Retail conditions in the mountain district are different. A large yard that stores any considerable amount of coal is almost unknown. Lump and egg coal are rarely put into storage. Hence the boxcar with its low floor substitutes for a storage bin and gives an easy method of shoveling the coal direct from the boxcar floor into the truck.

In many districts of the sales territory there is absolutely no demand for the finer sizes of coal. Due to the huge freight rates over these long hauls, the prepared sizes must be shipped with every possible pound of degradation removed, for the freight paid on a small amount of unsalable slack coal will pretty well absorb the entire profit on the car.

Another difference is gradually creeping into operation. This is the trucking of coal direct from the tipple to the bin of the consumer. This condition has reached such proportions that many mines are as well prepared to load coal into trucks direct from the tipple as they are prepared to load the coal direct into railroad cars. We cannot make any excuses for this coming change. It seems to all of us that it is a menace to the coal industry. Even though economically justified at present, it has taken a heavy tonnage away from the railroads which burn coal, and turned it over to trucks which burn oil. In some of our cities, it is almost eliminating the retail dealer, an economic loss to the town. In the present days of stress, thousands of trucks are driving in long distances, often from foreign states, wintering around the coal mines, paying no taxes, maintaining no roads, and putting our railroads and our dealers into financial straits. It is a condition that the mine has had to meet, or shut down. It is permitting the operation of a multitude of small mines without railroad trackage, without any real investment, no satisfactory regulation or inspection, and in many ways totally irresponsible. But the situation is here, many mines are prepared, others are preparing to meet it, and it is something that every tipple designer must bear in mind.

One of the largest producers in this region shipped 75 percent of its coal direct from tipple to bin.

We can't say that we are about to describe common practice in the Rocky Mountain district. Each of a dozen districts has its distinct differences and we are telling how each meets a peculiar phase of its troubles.

Structures are of all kinds, wood framework predominates in some fields. In others some really outstanding steel structures house tipples that are second to none in completeness. One mine built its tipple of reinforced concrete. Another mine is now building a steel headframe for its 900 foot shaft all of welded steel with not a rivet in it.

One of the newer installations in the Rocky Mountain region is described as follows and represents the latest practice:

The coal, of course, is loaded mechanically, and what huge coal it is. Electric and hydraulic shovels, scraper conveyors, working in veins from 7 to 30 ft. thick, deliver a size of coal that amazes the onlooker. The specifications for a tipple recently contracted read: "The crusher shall be capable of taking lump of 3 ft. cubes up to 3 ft. by 1½ ft. by 6 ft."

So the coal is dumped through these huge crushers and reduced to about 15 in. bar screen size before delivery to the shakers. Or, at one mine of large capacity, the reciprocating feeder forms a grizzly that holds out the large lumps which are broken through the grizzly by an air hammer operated by a man on a platform over the feeder.

This coal now should, but often doesn't, pass over a magnetic pulley to trap the tramp iron, but stoker demands are rapidly forcing their installation.

Shaking screens are as you know them. But they make a multitude of sizes. The simplicity of lump, nut and slack, or the ideal condition of run-of-mine, all direct into gondolas, is not for the Rocky Mountain district. Dust, pea, straight slack, nut, egg, railroad lump, 3-in. lump, 6-in. lump, 8-in. lump, and any conceivable mixture of these divisions must be easily and quickly made. And the prepared sizes must be loaded into boxcars, lump at all times, egg very often, nut at times, so a western tipple is a complicated screening plant of five to seven tracks, and one to three boxcar loaders.

Such elaborate sizing makes rescreening a necessity, so the smaller sizes of course, are usually screened separately over flexible hanger or vibrating screens, the products going to bins to permit rapid loading, the screened sizes being loaded over degradation screens, or small flexible hanger screens, or vibrating screens.

Coal cleaning is done about every possible way. The coarse sizes are picked over booms, usually over combination picking and loading booms. In a few cases, the picking and the loading booms are separate with degradation screens set between. Often the booms are set to swivel sideways to load gondolas or to deliver the coal alongside a boxcar to the boxcar apron. The West has developed the peculiar Knox boom, a swiveling goose-necked boom setting between two tracks, permitting picking, and delivering the coal to open or boxcars. It has been a boon to the old tipples that were built too low to admit the installation of picking tables, for it has the merit of receiving the coal from the screens at a low point, yet delivering it to the boxcar or trimming a gondola.

Rejections from the booms are of two kinds, rock and bony. Rock is clear waste and handled as such. Bony is often little less valuable as fuel than coal. Sometimes it is donated to the railroad to get rid of it, sometimes sold for local house coal, sometimes conveyed to a crusher to be broken to 3-in. and smaller and returned to the stream of coal, for its fuel value is high, and its appearance in large lumps is its only demerit.

Frequently in later tipples a mixing or gathering conveyor is installed so that the coal can be split into various sizes and streams for picking, then gathered together in various combinations for discharge onto the proper track. At times where boxcar loading is comparatively infrequent, one loader serves to load all sizes and the gathering conveyor serves it.

One tipple is equipped to load three sizes of coal into boxcars at one time. The lump coal is loaded on two tracks, one track for open cars, the other for boxes. Over the open car track is a flat top steel apron conveyor picking and loading boom. Lying next to this and parallel with it is the lowering boom to the boxcar apron. A plow on the flat top boom plows the coal off to the boxcar boom so that all the coal can go to either car, or part to each car. The boxcar boom delivers the coal gently to a mechanical transfer conveyor which serves as a boxcar apron and delivers the coal gently to the extension type boxcar loader. This, driven by a three-speed push-button controlled motor, can land a lump of coal in the highest corner of a boxcar without throwing it. The speed control is used only to give increased capacity in a period of rush.

Three of these extension boxcar loaders are installed in this plant, each with its transverse transfer conveyor from the loading boom to ease the coal to it.

The use of curved top picking tables from which the coal is gently pushed onto a screen type of transfer conveyor, thence to a slow-moving boxcar loader, has solved the problem of loading boxcar coal free from degradations. Some of these things are shown quite clearly by the illustrations.

The small sizes of coal are handled in different ways. No one way can be called common practice. Air cleaning has been tried at one mine, but the plant has been in disuse since a short time after its start. Mechanical slate pickers have never succeeded. Except in Colorado and New Mexico coal washing has not been done to any great extent. With the depletion of the cleaner seams being worked now, this cleaning method is bound to become a part of the future western coal preparation plant. There are a number of domestic washeries in Colorado, some reasonably large, some quite small. The larger ones are not unique, but the smaller ones are interesting. They are usually built of one or two jig cells fed by a conveyor, the coal discharged direct to the gondola over a fixed mesh draining screen, with no attempt to clarify the water or reclaim the fine coal.

(Continued on page 90)

Meeting the Safety Problems of the Rocky Mountain Region

By William Moorhead*

DURING 1914 one of the large coal producing companies in the Rocky Mountain region experienced considerable difficulty in retaining experienced machine men. This difficulty was caused by the excessive amount of coal dust suspended in the air while undercutting. The dust was so thick that it was impossible to ascertain how many men were at the face. Many of the machine men imagined they were getting much of this dust on their lungs and were frequently examined by the local doctor who advised them to discontinue working on the mining machines. The company officials decided to place water on the cutter bar to saturate the dust at its source with such splendid results that no more trouble was encountered to keep good men on the machines. This simple method of killing the dust at its source not only made it possible to retain good machine men, but started the system, in this region, of wetting the dust as a safety measure, until today very few mining machines are cutting in the Rocky Mountain region without sufficient water running on the cutter bar to thoroughly saturate the dust as it is made.

About this same time some of the mines in the Rocky Mountain region had traveling ways driven through the outcrops. At the entrance of some of these traveling ways the floor was in adobe soil and it was noticeable that the traveling of men and animals caused much of the adobe dust to be suspended in the air and later deposited on the roof, ribs, and floor some considerable distance from its source. Later on many of the far sighted officials dug this soil from the adobe banks on the surface and spread it along the traveling ways and haulage roads in their mines. Men were even employed to sack screened dust from some of the dusty highways and this was deposited along the main roads. In this manner many of the mines in the Rocky Mountain region were rock-dusted in the traveling ways and haulage roads. This work was done many years before the rock-dust campaign was started. Today very few mines are operating in this region that are not more or less rock-dusted and a great many are maintaining the rock-dust from the mine portal to within 10 or 20 ft. of every working face. Not only are all working places in many of our mines rock-dusted but all open accessible abandoned workings in many of the mines are thoroughly protected by adequate rock-dusting.

Very little coal is loaded in the mines of the Rocky Mountain region before it is thoroughly sprinkled. Most of the mines have sprinkling lines extended to every working face, in each place at the end of the line is a hose. In these mines each miner and loader is compelled to sprinkle the loose coal before starting to load and to frequently wet the face and its vicinity during the working shift. In the majority of the mines the working face must be thoroughly wet down before shots are fired and in many cases sprinkling is done between the firing of shots. Particular stress is laid on the sprinkling of loose coal when loaded with mechanical units. For many years the thought prevailed that the use of water provided adequate protection against coal dust. We, in the Rocky Mountain region, have learned from rather costly experience that this idea is erroneous. Much of the coal in our region has a high volatile content, ranging from 40 to 50 per cent, hence it is highly inflamable. This coal dust is enhanced by the addition of resin in dust form which content is found in much of our coal. The mine conditions are further handicapped by the extra dry climate and in many cases by the extra heavy cover. To overcome the above-mentioned adverse conditions some of the most drastic coal mining regulations are in effect and the state coal mine inspectors take pride in making the operators live up to requirements.

The metal mining industry has taught the coal operators many points in safety. We know the "hard boiled caps" and "hard toed shoes" were proved a huge success in the metal mines long before they were extensively used in the coal mines. At present very few mines are operating in the Rocky Mountain region where hard caps are not in use and in many of the mines the men are 100 percent with "hard caps"—"hard toed shoes"—and goggles.

The safety campaigns inaugurated in the metal mining camps proved so successful that it was necessary for the coal operators, who wished to keep in step with them, to emulate their methods of educating the miner. It was also found their system of selecting safety committees from the officials and the workmen was, more or less, the missing link. The chief duties of these committees was to establish safe and better working conditions for the workmen in their department. They make a study of the general conditions, departmental and occupational hazards and practices, and endeavor to encourage the cooperation of their fellow workmen in promptly reporting for correction any existing unsafe conditions or practices through which personal injury might result. Committees such as these were formed at many of the coal mining camps resulting in splendid results. At present many of the camps hold mass meetings for all employes once a month. At these meetings criticism of faulty practices and conditions are encouraged from the men and during the numerous discussions many excellent suggestions are obtained.

The almost exclusive use of permissible electric cap lamps has done its part in making our mines safer. The permissible magnetically locked flame safety lamp is used for inspection purposes and is also used by all machine men as well as officials. The machine men must first examine the place for gas before moving into it and the shot-firer tests for gas before tamping the holes. Nothing but permissible powder is used in the larger mines and this fired electrically. At the majority of the mines the miners never see the powder as it is taken in with the shot-firers after the shift is out. All holes are tamped to the collar with dummies filled with incombustible material.

The most of the machinery purchased in the last few years has been permissible and the trend is decidedly moving to exclusively permissible machinery.

In some of our mines a system of power lines is used, while it is not altogether new, nevertheless it is unusual. Power is carried from the surface in armoured submarine cable and spread out to the various sets of transformers in the neighborhood of the live workings. This cable is usually entrenched in the floor and out of sight. The transformer houses are constructed of noncombustible material with a suspended self-closing door which automatically closes in case of transformer fire. From these transformers secondary armoured cable is laid into the working places. Junction boxes of permissible type are used for connection of cutting machine and drilling machine cables. With this system of power lines all faulty installations of power lines is eliminated. The wiring is on the floor and with the additon of the permissible junction boxes; hence all arcing is eliminated when disconnecting cables.

The extensive adoption throughout our region of panel systems whereby one panel is absolutely isolated from another lends itself to sealing off of abandoned workings when finished or not needed, and keeps away from the hazardous system of too much interconnection of entries and even mines. It assists materially in controlling ventilation and allows better concentration of work, and leaves no doubt about it being safer.

Many of the large companies in the Rocky Mountain region are making enviable records in injury prevention. Almost all the larger companies have 100 percent of their employes trained in first aid to the injured. In fact, one large company in our region had 100 percent first-aid training in 1924. We know it pays both from a humane standpoint and financially.

Thus we are meeting some of the safety problems of the Rocky Mountain region. We do not claim we have more problems than someone else or are meeting them in any better manner than in some other region; but we think we are attacking these problems from the proper angle.

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* General Supt., Utah Fuel Company.

Accident Prevention with Protective Caps, Hard-Toed Shoes and Goggles

By David W. Jones*

Discussion by A. J. Ruffini† C. W. Gibbs‡

THE introduction of protective caps, hard-toed shoes and goggles for the use of men employed in coal mines required both patience and persuasion. A few of the men grasp the merits of safety suggestions and wear the safety articles, not only as insurance for their own personal safety, but to encourage others who are not so careful and are more likely to suffer a preventable injury. Such men deserve credit for their good judgment and intelligence.

A second group of men give an attentive ear to safety suggestions, but their minds do not concentrate a sufficient length of time to cause them to become safety conscious.

A third group comprises men who have been persuaded to take precautions against preventable injuries, either by actually suffering from such an injury or by witnessing one to a fellow-workman.

The rest of the men are in a class which is indifferent to safety suggestions and even after being injured, will not make an effort to be more cautious or will not be inconvenienced by worrying about a recurrence. Such men are inclined to feel that their destinies are predetermined and are the hardest ones to deal with in safety matters.

After the Valier Mine was fully mechanized, a study of the accident reports indicated that the new methods of mining had reduced the number of the more serious injuries, but the number of minor injuries had increased. Most of the avoidable ones were to the head, toes and eyes. It was realized that it would be necessary for the men to wear hard-crowned caps, hard-toed shoes and goggles to protect themselves against injuries of this nature. They are always accidental, for a man will not deliberately subject his head to a hard blow or stand under a falling rock which might crush his skull. He must wear a safety cap at all times while in the mine to protect his head when the unusual situation is encountered. Likewise, a man must wear hard-toed shoes at all times while he is working, for he does not know when he will drop a rail or prop on his toes and break them. Goggles are in a different class and it is not necessary for a man to wear them continuously. Each man can not be protected with the same type of goggles. Wire screen goggles will protect the eyes of cutting machine men and pick men in a practical way. Wire screen goggles can be cleaned quite easily and can be put on and taken off just as frequently as the wearer feels that they are required. A machine man should wear a safety cap to protect his head against falling jack-pipes, as such accidents are common and often serious. A motorman should wear a pair of goggles fitted with non-shatter glass to protect his eyes against particles carried in the ventilating air. A motorman should, by all means, wear a safety cap. A striking example of the protection gained by wearing a safety cap occurred when a main line motorman raised up from his seat to put the trolley pole back onto the wire after it had jumped off and struck his head against a cross-bar. The blow was sufficient to knock him down into the cab of the motor and stun him temporarily. If this man had not been wearing a safety cap, undoubtedly he would have been knocked unconscious and fallen out of the locomotive onto the track while running at fairly high speed. For men working in air courses and exceedingly dusty places, a close fitting type of rubber goggles with safety glass is well suited to keep the very fine dust out of the eyes.

It is not sufficient to suggest to the men that they equip themselves with the different safety articles to avoid preventable injuries. Such articles must be accessible and available for use at the opportune time. A man may narrowly escape toe injury many times during a day and then sincerely decide to purchase a pair of safety shoes and not take further chances. However, unless it is possible for him to obtain safety shoes without much inconvenience, it is likely that he will not do so until after he has been injured.

At the Valier Mine, a small quantity of the safety articles recommended to the men for their use were offered for sale through the storeroom by payroll check-off. The hard-toed shoes were priced at practically cost. The hard-crowned caps and various goggles were offered to the men at one-half the cost price.

The serious thinking men referred to as belonging to the first group, responded immediately and among the other men there was much criticism as well as praise for their efforts. Men were curious to know to what extent benefit was afforded. The safety caps and hard-toed shoes especially, were subject to much inspection and test. The results in general were favorable and after many of the men became accustomed to wearing the caps and shoes, the novelty wore off and no inconvenience or discomfort was noticeable. After several cases had been reported where head, toe and eye injuries had been prevented by these safety articles, the men in group No. 2 began to line up with the safety-thinking ones. After a number of men in group No. 3 had been injured and had been talked to along safety lines, they realized how much better off they would have been with protection at the low cost offered. When they returned to work, they were equipped with protection and they were the means of convincing others of the advantages to be gained by using every safety precaution possible. For instance, practically all of the regular timbermen purchased safety caps after learning of the experience of one of our men who was struck on the head by a piece of falling slate, weighing about 8 pounds. A sharp corner of the rock struck the front of the hard-crowned cap, tore off the lamp bracket and cut into the cap. There was no question as to what the result would have been, if this man had not had on a safety cap.

Many eye injuries were prevented by the timely wearing of goggles. One man wearing a pair of goggles with safety glass, had one lens completely shattered and to his surprise and happiness found the eye had not the slightest injury. A number of damaged specimens showing dents in the hard toes and crushed toe caps where injuries had been avoided, were obtained from men wearing safety shoes. Other foot injuries had been made slight instead of serious where the blow was struck on the foot between the toes and instep. A motorman presented a pair of goggles showing small pieces of copper imbedded in the glass, caused by the trolley pole flying off and the arc throwing molten copper.

In order to give publicity to some of the more serious accidents which had been avoided, a display cabinet was mounted on the bulletin board at the shaft. The new, as well as the damaged articles were shown, with the history of the accidents printed on small cards. It was soon apparent that our efforts along safety lines were being rewarded by fewer preventable accident reports covering injured heads, toes and eyes.

After the first 100 men had been converted to the safety class, we planned to reach the second 100 men who wanted the safety protection, but offered excuses for not being able to obtain it. Accordingly, it was announced that each man who had purchased a safety cap at one-half price would be given full credit for the amount he had paid for the cap when he pur-

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chased his second pair of safety shoes. Employes thereafter who purchased their first pair of safety shoes at the regular price would be given a safety cap for use in the mine—free of cost. In other words, the company agreed to equip each man with a safety cap who wore safety shoes.

The wearers of goggles were informed that the company would replace broken lenses and rubber bands which were broken or worn out in the mine. In cases where men required prescription lenses in goggles, the company still agreed to pay one-half the purchase price and send away the man's regular glasses to have similar correction applied to the safety lenses.

This program was continued until the second 100 men were lined up for safety, and again plans were made to attract the third 100 men to the safety-thinking class. Many men felt that it was necessary for them to completely wear out all their old ordinary shoes before they could afford to purchase new safety shoes and this condition led to the announcement that employes could purchase safety shoes and be given a safety cap free, on a partial payment plan of a 50-cent check-off per pay period. This plan had immediate response and we are now following it. The best day for shoe sales is our regular pay day, when a man buys a pair of safety shoes, knowing that he will not begin paying the 50-cent check-off until the next pay day. Thus, the men are paying for the shoes as they are wearing them out. As the shoe sales increased, the cost of handling and stocking became self-supporting and it became necessary to stock a few different grades to satisfy the peculiarities of the men. Heavy safety shoes were provided for those who were not required to be fast on their feet. Lighter types and more flexible safety shoes were offered to trip-riders and men engaged in active moving.

In conclusion, I wish to state that we feel that our efforts have been rewarded, both from the standpoint of operating efficiency and financial expenditure. The accidents prevented have more than paid for the expense of providing first class safety caps and goggles. Aside from the pecuniary interest which started the safety campaign, it has been a source of gratification to see a man display a safety cap which had saved a fractured skull, or see the crushed toe of a safety shoe which had saved the toes of a man and enabled him to continue work.

After all, the safety cap is the most essential safety device offered. Most of the broken bones of the body will mend, but a crushed skull is nearly always fatal.

A satisfactory reward comes in knowing that the sight of an eye has been saved, by making it possible for an employe to protect his eyes with goggles furnished to him at one-half price, because if merely a suggestion had been offered instead of the article itself, the man would not have responded to it.

In time, we hope that the safety caps, safety shoes and goggles will not be looked upon as accessories in the mine, but become so generally used that the men who do not make an effort to avoid preventable accidents with them will be in a small minority.

Valier Mine Reportable Injuries, Man-Shifts Worked and Man-Days Lost

During the first three months of the year 1932, there were 147 reportable injuries for 31,840 man-shifts worked, or an average of 216 man-shifts worked per injury reported.

Out of a total of 147 injuries reported, the total lost time amounted to 313 man-days. These 313 man-days were lost as follows:

Per-cent				Days each
33.2	Two men with crushed hands lost........	104	Man-days	52
26.2	Three men with broken legs lost.........	82	Man-days	27
9.3	One man with an injured eye lost.......	30	Man-days (not wearing goggles)..........	30
6.0	One man with crushed toes lost..........	18	Man-days (not wearing safety shoes).......	18
25.3	The balance of the time, or..............	79	Man-days were lost by 14 men which amounts to an average of 5.6 man-days lost per man.	5.6
100.0				

A. J. RUFFINI—*Wheeling Township Coal Mining Co.*

MR. JONES' paper certainly carried all that I would have to say, and the only thing I can do is add a little more fuel to the fire, this fire of enthusiasm for safety and for safe practice that is continually spreading not only throughout the operators but also among our employes.

I certainly must agree with Mr. Moorhead when he said that the coal mine operators and employes are far behind metal mines in safety devices for their employes.

As I see it, Mr. Jones' company is certainly attacking this problem in the right way, for I understand this was not a compulsory way of putting across this safety-toed shoe or hard-boiled hat or goggles, but merely a plan to sell the employe on the points that can be gained by wearing the different safety devices.

I really think that is the way we should absolutely sell this idea to the employes. They will, therefore, be sold from then on, and you will not have to go through the entire program.

I am not standing up here talking against certain companies in the districts or in the fields throughout the United States, but it is a very easy matter to put up a sign that after such-and-such a date everybody must wear safety shoes or hard-boiled hats or goggles, or come to the office and get his money. Perhaps in this day of economic depression we can get away with that program in certain districts, but I do not think you will sell the man 100 percent, for no man likes to be told he must do this and must do that. I think Mr. Jones' company should be commended on the way they put this program across in making it a voluntary program and selling the men absolutely.

I would like to discuss at this time exactly how we put the idea over on a voluntary basis. Our mine is a 100 percent mechanical mine. The minute we went into the mechanical loading, our frequency rate jumped tremendously, our severity rates went down but the frequency rate practically quadrupled itself in a very few minutes.

In analyzing the accidents for 1930 we found we had 16 lost-time accidents due to toe injuries. These 16 accidents were outstanding, where the men had lost from three weeks on up, due to mashed toes and so forth. We decided in 1931 to start a safety program on toes to see if we could not eliminate these accidents.

We started out by putting the safety-toed shoes in our supply room and selling them to the men at cost, and checking it off over the pay roll. We put posters up and by word of mouth with the foremen and in our safety meetings stressed the idea of selling the shoes to men, and by February 1 had about 50 percent of our men wearing the shoes. We also used different posters similar to other companies in showing the different points of safety, especially if the man had a toe injured. We would put the shoe up and show how the safety toe prevented a more severe injury or how a safety-toed shoe would have prevented further injury.

This went along until about July 1, and we had about 80 percent of our men wearing safety-toed shoes, and also a few stragglers that you couldn't sell even if you gave them a pair of shoes. We did not make it compulsory. We still maintained we could make it voluntary, even if we did have to resort to high-pressure sales to sell the last few men.

By December 15 we had every man in the mine, but one, wearing a safety-toed shoe. I decided it would be a good idea to call that individual in and ask why he objected to the safety-toed shoe. He said, "Well, I wear arch supports in my shoes and you don't have shoes with arch supports." I said, "We will get you a pair with arch supports." The next day he went up and bought a pair of shoes without the arch supports, because he decided he might as well fall in line.

In order to give you a little idea of our history along with the safety-toed shoes, in 1930 we had 60 lost-time injuries, representing about 15 percent of all the injuries in our mine and about 35 percent of the lost-time cases in our mine. In 1931, during the year we were putting the program over, we only had six injuries, a reduction there of approximately 65 percent in lost-time injuries due to toe accidents. In 1932, although we have 100 percent safety toes, we have had so far one injury, and if he had not been wearing a pair of safety-toed shoes, that man today would have about four toes less, because he went sound asleep on his job and let a Joy loading machine caterpillar walk up on his shoe before he realized it. The result was he lost a big toenail and about three weeks' work.

There is no doubt about it, our men in our mine are sold on the safety-toe shoe. We did not make it compulsory. It is voluntary and at no time do we have to approach the problem of selling another man a pair of safety-toed shoes.

There is one thing I imagine some of you who have the safety-toed shoes in your minds will perhaps have to answer and that is: what are you going to do when a man wants to get the shoes half-soled and come to work with another pair? I tell the individual, "What did you do, come barefooted when you wore the other type of shoe?" He says, "No, I had another pair."

I say, "You get yourself another pair

or take the shoes to a cobbler and wait while he half-soles them this evening."

There is no excuse now for men in mines not having a safety-toed shoe, and I certainly agree with the system Mr. Jones' company used in making it a voluntary program. If you are thinking about putting something over, let's put it over voluntarily, even though in this day and age we might be able to get away with compulsory ideas.

When new men are hired in our mine we ask them to purchase safety-toed shoes. We don't compel them to do so. We set forth our program, tell them all our men have safety-toed shoes, and we would like to have them buy a pair before they go to work. They fall in line very quickly.

As to hard-boiled hats, we have had about 20 hard-boiled hats on hand and we give these hats to different individuals throughout the mine, just to get more familiar with them. We are in a somewhat different circumstance from a mine that has high coal. Our coal is only 4½ ft. high, and a man is generally in a stooped position when walking through the mine or working and if a piece of slate falls, it hits him generally on the back of the neck or the shoulders. So before we go into the hard-boiled hats, we want to be absolutely sold on them ourselves, that the men will actually do the work they set out to do.

We have goggles for our tipple hands and any man working on grinding stones and so forth, and the drillers in the mine who have grinding stones on their outfits to grind their augurs are equipped with goggles. So far we have not carried the goggle idea out to all of our men. In the near future we hope to do this. Right now we believe in putting over one program at a time, and we are trying to put over the safety lamp program. We have to this date about 100 out of a possible 220 men that are wearing the safety lamp, and if we had not had this labor condition in the last three weeks, I believe we would have been over 100 percent.

I want to leave this point with you: if you are going to put over any of these safety programs, I think the best way to put it over is to put it over voluntarily and not use any compulsory means. It not only reflects on your own company, but if any labor conditions arise in the district, everybody that even thought about putting on hard-boiled hats or safety-toed shoes bears the brunt.

C. W. GIBBS—*Harwick Coal & Coke Co.*

HARWICK mine is located in Allegheny County about 18 miles north of Pittsburgh, along the Allegheny River, with a shaft overburden varying from 250 to 600 ft. The roof conditions are good, medium and bad. Someone used the expression "rotten," we have some of that. The coal seam generates gas; the mine is, therefore, classed as a gaseous mine.

Rock Dusting

When rock dusting in the mines was advocated in this country a few years ago, we adopted the idea and were the nineteenth mine to be accepted as 100 percent rock-dusted. This was accomplished by completely dusting all the so-called fresh-air entrances and erecting rock barriers to protect the return entries.

About two years later, the Compensation Board ruled that the barriers did not entirely meet the requirements and it would be necessary to dust all return entries. In the case of an old mine, such as the Harwick mine, this is quite an undertaking, but we started; the work being completed some six months ago. We dusted by hand 23 miles of so-called return air entries. I am pleased to say, at the present time we are credited with the mine being 100 percent rock-dusted.

Our engineers in some way rather underestimated the length of the return entries necessary to dust, or I think we might have been inveigled into buying one of the high-pressure rock-dusting machines.

Mine Refuge Rooms

Several years ago there was disaster in a mine, following which the lives of several men were saved by barricading themselves in the room until rescued. One of our officials asked at that time why special arrangements could not be made for places in which a man might take refuge in case of disaster. While it was admitted it would be an advantage only in case the men were able to reach them, we nevertheless proceeded to construct three so-called refuge rooms located at central points relative to the operation of the mine. These rooms were cut in the chain pillar about 75 ft. long, 12 ft. wide and 10 ft. high. Doors forming an air lock led into these rooms. We found it was necessary to drill 2 8-in. holes from the surface, and in the small building, in the surface over the holes we located an air pump operated by a 15-hp. motor, suspended in one of these holes, lead-covered cable, having telephone, electric light and power circuit. The pump on the surface can be started by pushing a button in the chamber or on the surface and a volume of fresh air is delivered into the room through one of the pipes. The exhaust air goes out of the second borehole.

The power and telephone lines are carried over the surface to the location of the building over the refuge room and through the bore holes, providing means of illumination and conversation.

A rather ingenious device, which it is beyond my powers of description to explain to you in detail, was developed by our engineers and our telephone department, so that in case of trouble developing with any phase of the electric circuit leading to the refuge room, the signal is given in the superintendent's office and also in the general substation at the mine. This device also indicates on a paper tape, similar to a stock-ticker tape, the particular station at which the trouble exists.

Fortunately, these rooms have never been required, but they are maintained in first-class working conditions at all times. At one end of the room we have a cabinet with glass doors in which we keep the tools and first-aid equipment that might be necessary in case of trouble.

I have contended that they would be very valuable in case we were unfortunate to have a mine fire started, as an auxiliary base. I hope we never have to use them for anything more serious than that at least.

Protective Clothing

About two years ago we were convinced that protective hats, hard-toed shoes, and goggles, if adopted by our men, should materially reduce some of our minor and lost-time accidents. It has always been my idea that safety must be sold and could not be forced. Therefore, we agree with the previous speakers.

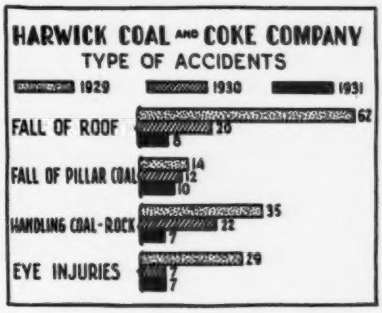
We had a cabinet constructed with a light inside, in which we exhibited the protective hat, hard-toed shoes, boots, and types of goggles. These we offered for sale to the employes at wholesale rate, except in the case of the protective hats, which at that time sold for around $3.50 each. They were, by the way, the helmet type, the first kind introduced. We also showed the self-rescuers, which at that time I believe sold for about $7. In the case of the two last items, the company agreed to assume $1 of the expense for each item. At the present time the cost of these items is down to a point where, as I will explain later, we have sold our men 100 percent. We charge the men the actual cost to the company, with no handling charges of any description. If they so desire, we will deduct the cost from the pay roll on time payments.

Our supervisory force adopted the hats at once and, after a short time, the men, without any compulsory action, commenced to purchase the safety equipment and, within a few months, we were so nearly 100 percent on the hats and shoes that we insisted, contrary to Mr. Ruffini's idea, that the balance of them should equip themselves in that way. It was a very small number, however.

A good percent of them had purchased the goggles, especially where they were loading, operating motors, or timbering. At the present time any new employes hired we insist on their equipping themselves with hard-toed shoes, protective hats and goggles, and also upon their wearing them all the time, inside of the mine, of course.

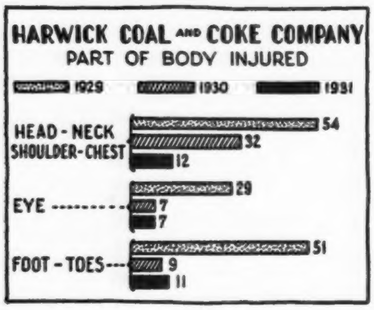
We feel justified in crediting the result of accident reduction at least 60 percent to the adoption of these protective devices.

It has been most gratifying. I have two or three slides I am going to show now, which will probably picture to you, better than I can tell it, what we accomplished in the way of accident prevention since we adopted these precautions the latter part of 1929 and the early part of 1930.

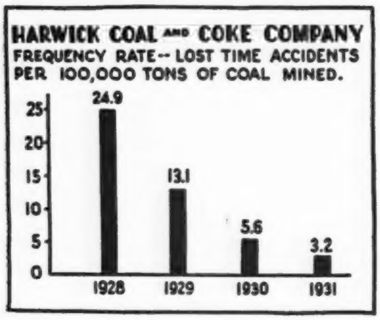


The number of accidents in 1929 are shown by the dotted space, the number

in 1930 by the hatched space, and the number in 1931 in solid. They show the actual number of accidents in the various classifications. Under falling of roof in 1929, 62; in 1930, 20; and in 1931, 8. Fall of pillar coal, 14, 12, and 10. Handling coal and rock, 35, 22, and 7. Eye injuries, 29 in 1929, and 7 each in the years 1930 and 1931.



The parts of the body injured in 1928—head and neck, shoulder and chest—which we feel was helped very greatly by the protective hats. I would say it is a matter of your own opinion and judgment as to what portion discipline and education can be credited with. I am willing to credit the protective devices with 60 percent of that reduction at least. In 1929, 54; in 1930, 32; and in 1931, 12. Eye accidents, 29 in 1929, 7 in 1930, and 7 in 1931. Foot and toes, 51 in 1929, 9 in 1930, and 11 in 1931, which is two more than in 1930.



The frequency rate of lost-time accidents. I am not showing you this slide because we are at all proud of it. I think it can be beaten. Many of you have better records. But it does show the decrease and what is being accomplished in safety at our operation. We are personally proud of it, due to the comparison from one year to the next. That slide I think speaks for itself.

There is the old man himself—Old Man Safety. I want to say his goggles are in his coat pocket. You do not see them, but they are there. He has one of the self-rescuers. That illustrates the form of helmet-type hat we first adopted at Harwick. Since then we have permitted the men, if they desire, to use the Skullgard type. At another operation in Greene County, Pa., we have put the program across in exactly the same way by exhibiting the articles, talking to the men at the safety meeting, as Mr. Jones said they did, selling them the idea and making it as easy as possible for them to buy without assuming the expense ourselves. We have found that the men were willing to cooperate in that way.

The type of hard hat illustrated has protected two men from fractured skulls. One case where a man was struck with a slab of slate on back of the head and shoulders. The slab was some 4 ft. long and 3 or 4 in. thick, and 18 in. wide. It was measured by the safety inspector immediately after the accident. The man was bent over in the act of lifting a rail. The slab dropped, striking the hat. The only injury to him was in jamming the hat down over his head so far that it scratched the skull slightly just above the ears. He lost no time.

The other fellow tripped while in his room, fell backward, and the hat struck a sharp point of bony coal with such force that it punctured the hat. A hole three-quarters of an inch on each side was poked through the hat and punctured the leather lining enough so that as the hat slipped his scalp was cut about 2 in., but only a scalp wound. There is no question in my mind a blow like that and a pointed object would certainly have penetrated his skull, if it had not been for the hat. So we are sold on the idea, and we find our men are.

Mr. Ruffini referred to low coal. At our operation in Greene County we are working in what is known as the Sewickley seam of coal, averaging about 54 in. of thickness. For my part, when I go into that mine I want a protective hat on my head. We find the men appreciate it themselves. There was some complaint that they are warm, but they very soon get used to it. We have very, very few complaints.

I agree with Mr. Jones, if we could find some way of protecting the hands, it would be a wonderful thing.

As you have some of those figures I just showed you in your minds, it is rather interesting to note that in the State of Pennsylvania, during 1931, there were 473 men killed in industrial and mine accidents (those are not separated) by falling objects. The falling of lumber, rock, and coal caused the death of 265 workers in the anthracite mines and 160 workers in Pennsylvania bituminous mines during the year. So I think it is well worth your while to give this protection all the consideration you possibly can.

Education and Discipline

One thing we feel very essential is the educational feature which has been referred to by both of the gentlemen preceding me—education with discipline. We have had discipline enforced for a good many years, and yet something happens and the accidents still occur.

We have entered the age of mechanical safeguards. This was something we could do and did do. This was a concrete proposition whereby certain risks and dangers could be made safe for the workmen. Accidents were reduced, but not enough. The men in charge of the operation would say, "I can't understand it. We have discipline, but we still have accidents."

It is a case of man failure, gentlemen. Men learn more or less monkey-fashion what they must do and must not do, and that they will be punished or disciplined for infractions of the rules, but very few go far enough to think where those rules and laws are made. Some of them are careless. They simply go along and protect the jobs.

I have thought it might be well sometimes if our State mine examinations could require or contain some questions to determine a man's ability to study the men he is employing or that he has under him—the psychology of it, if you please.

We find that we have done as much toward reducing accidents by an educational campaign that we put on a few years ago as by safeguarding and discipline.

There is no doubt in our mind that the Pennsylvania State mine law is more efficient than that of any of the other States. Being from Pennsylvania, I will put it that way.

Several years ago we put out a little pamphlet which we called "What a Miner Must Know." I think most of you will agree with me that the miner feels that the State mine law is something for the operator or the manager to worry about. With that idea in view, we had a small pamphlet prepared, in which we outlined the rules of the company and gave extracts from the law which had to do with the miner himself, wherein he was guilty of violation if he did not live up to those laws.

We asked them for their cooperation with the rules and regulations as outlined in that book. That was not unique in any way. The feature in it that I thought brought us good results was an examination of each man on the contents of the pamphlet. Each section assistant foreman took the books for his men and distributed them and told the men they were expected to read or have read to them the contents of that book.

Within a week or two after the book was given out, some official of the mine—an assistant safety inspector, superintendent, or mine foreman, some one of the officials—made it a point to personally examine the men. They questioned them on the contents of that book, and by picking a few questions here and there they could very readily tell whether the men had actually read the book or knew what it was all about. If satisfied that the employe knew what was contained in the book, he certified to that effect on the last page of the book. The examining official, after dating and signing it, turned it in to be attached to the personnel file of the man with his application and other papers.

Our men are given physical examinations when employed. We do this at least every two years, or oftener if the man so desires.

We feel that report and the examination is going to awaken the men to their own responsibility. We believe it has brought about some good results. We have educated the man that it is his own responsibility for the safety of himself. We have guarded all the machinery and have guarded the miner against certain injuries by insisting upon the protective hats. I use the word "insisting" now, for that is our status at the present time.

Man Failure

It was stated by no less authority than Harold S. Herbert, in the last National Safety Congress in Chicago, that 95 percent of all accidents can be attributed to this man failure.

To my mind, a most beneficial accident preventative would be the correction of this man failure. I have studied it from

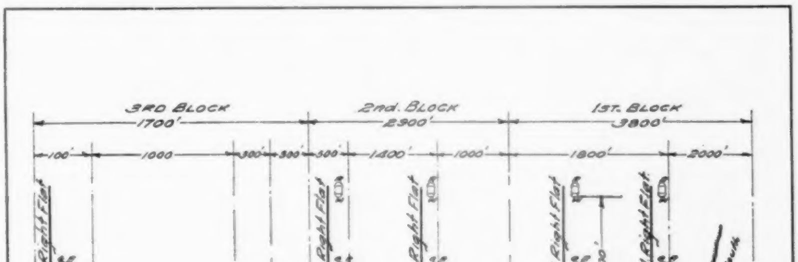
(Continued on page 92)

Automatic Block Signals for Mine Service

By L. C. Skeen*

THIS paper will describe the operation of a system of automatic signals which has been installed in one of the mines of Fordson coal Company located in Pike County, Ky., on a branch of the Norfolk & Western Railroad, about 10 miles from Williamson, W. Va. The mines in question are drift operations in a comparatively level seam, producing normally about 8,500 tons of coal per day. In addition to the Pond Creek mines of this company, we also operate a mine at Twin Branch, McDowell County, W. Va., equipped with automatic block signals and electric switching equipment on main haulage.

The initial installation in No. 8 mine covered the main haulage entry and one of the gathering motor side tracks and consisted of three blocks of signals, the first block beginning at the drift mouth and extending to the passing track above Third Right Flat, with a signal unit at the drift mouth, a signal unit at the mouth of Second Right Flat 2,000 ft. from the drift mouth, a signal unit at the mouth of Third Right Flat 3,000 ft. from the drift mouth, and a signal unit at the lower end of the side track on the main above Third Right Flat, 3,800 ft. from the drift mouth. This last unit was equipped with duplicate setting and



clearing contactors so that one of each could be located on the trolley wire of either track of the passing side track, permitting motors to pass on either side, or operate through in either direction on either track, in case of obstruction on one of these tracks.

The next, or second, block consisted of a signal unit at the upper end of the passing side track above Third Right Flat, a signal unit in the mouth of Fourth Right Flat a distance of 1,000 ft. from the passing side track, a signal unit in the mouth of Fifth Right Flat, and a signal unit on the main above Fifth Right Flat, a distance of 2,900 ft. from the passing side track.

The third block consisted of a signal unit on the main below the mouth of First Left Butt, a signal unit in the mouth of First Left Butt, and a signal unit at the upper end of the gathering motor side track a distance of 1,000 ft. from First Left Butt. The signal unit at the upper end of the gathering motor side track was equipped with a sufficient number of setting and clearing contactors and signal indicators so that one each might be placed on each gathering motor track leading into the side track, so that gathering motors would be protected from each other, as well as the main-line motors.

The operation of a train over this signalled section of single-track haulway is as follows: A trip, carrying a red trip light on rear car, leaving the tipple yard inbound, sets the first block signal as the motor nears the drift mouth, obtaining a green or "Go" signal indication immediately in front of the motor as the trolley wheel passes through the setting contactor, and a red signal showing to the rear for rear protection. At the same time, red signal indications are set at all other points of entrance to the block. The motor may leave this block at Second Right Flat, Third Right Flat, or go out of the block on either track at the passing side track on the main just above Third Right Flat, clearing his signals after the rear of his train has passed the clearance line at any point where he may leave the block. The motor, after passing out of this block, may enter the next block, provided the signal indicators of the block about to be entered are dark. Proceeding, he will receive a green signal indication, provided some other motor has not entered the block from some other point before he reaches the setting contactor. In case of simultaneous entrance of two motors, the motor entering the block from the preference point would set the green or "Go" signal indication and the other motor would set a red or "Stop" signal indication. After passing through the second block, the third block would be entered at a time when the gathering motors were clear, or away from the side track, the entering motor setting red signal indicators against all gathering motors. These signal indications would remain set until the motor pulled out of the side-track area. The motor would then proceed to the tipple, gaining green signals before entering each block, thereby reducing the waiting time to a minimum, the motorman watching out only for fallen rock in the track, red trip lights on cars that might be lost from a preceding trip, and the signal indications as he approaches them.

The equipping of the main haulways with automatic block signals was considered for safety reasons only. Experience had taught us that where more than one main-line locomotive operated over a single track collisions were likely to occur, due to an oversight or negligence on the part of a flagman or motor boss. We were trying to get away from the personal factor, if possible. Other automatic equipment has demonstrated that, where it can be used, it is more satisfactory than hand operation of the same equipment. With safety in mind, we installed the first system in our No. 8 mine, the operation of which will be described.

The installation of, and operation by, this automatic block signal system not only increased the safety factor of the main haulage system but also eliminated the necessity for three flagmen (one located at the mouth of Third Right Flat and side track, one located at the mouth of Fifth Right Flat, and one located at

* Fordson Coal Co.

the side track above First Left Butt), thereby removing the human element and using the more dependable automatically operated scheme, affording full protection 24 hours per day, every day, for any equipment operated over this signalled track. The operating efficiency of main-line haulage motors was increased about 15 percent by the elimination of unnecessary waiting time at passing side tracks and points of entrance to the main-line track, and the reduction of operating time between the side tracks and tipple.

A further study of the haulage system of this mine was then made, with a view of extending the signal protection to gathering motor side track areas, for the protection of one gathering motor from another, and the protection of main-line motors while operating in the vicinity of gathering motor side tracks. Consideration was also given the signalling of all tracks used by two or more motors. It was found that, by installing a secondary or hand-operated signal circuit for each gathering motor operating to a common side track, and also such a circuit for the main-line motor while operating in the side-track area, the operating safety factor at these locations would be improved and that it would be possible to eliminate a flagman from each common side track. The secondary signal system permits only one motor to be at the side track at one time, and eliminates lost time by preventing congestion of motors at side tracks, as well as preventing motor collisions.

It was found that by using electric switch throwers at all points of departure from the main haulway, remote control of one of the coupling pins on main-line motors, and the proper arrangement of side tracks and switches, couplers could be eliminated from main-line motors, thus doing away with the most hazardous occupation connected with main-line haulage and at the same time increasing operating efficiency. Electric switch throwers were installed at Second Right Flat, Third Right Flat, each end of the passing side track, Fourth Right Flat, and Fifth Right Flat, enabling main-line motormen to align track switches as they approached them. This is accomplished by setting the motor controller handle in a certain position as the trolley wheel passed through a contactor on the trolley wire, before reaching the switch to be thrown. These electric switch throwers are equipped with "Power On" and "Power Off" control and equipped with a two-unit indicator with orange and purple lenses to indicate the position of the switch points. The trolley contactor for control of the electrically operated switch may be located a sufficient distance ahead of the switch to permit the motorman to bring his motor to a stop in case he should fail for any reason to properly operate the switch in the desired direction. A cocked switch is indicated by neither of the indicators showing. The operation of the switch is affected by the trolley wheel passing through the contactor with the motors drawing power for one direction of operation and by the motors not drawing power for the other, or opposite, direction. The speed of travel of the trolley wheel through the contactor does not affect the operation of the switch thrower, as the closing of the control circuit is instantaneous and the opening of the selector contactor is controlled by a sufficient lag, which is adjustable, to assure positive operation. This equipment is protected against electrical failure, should a trolley wheel be stopped for any length of time in a contactor, for once a switch has been thrown in the indicated direction, the control opens and will not reclose again until the position of the motor controller has been changed.

In the switch-throwing device we are using, the solonoid coils are sealed in a water-tight cylinder; it may be operated under water if desired, or located any reasonable distance from the track. The switch points are held tightly in place under spring pressure. The switch requires control only from the direction approaching the points; when the approach is through the frog, the motor is operated through the switch with the points in either position without damage to the switch, or danger of derailing even light equipment.

With the installation of automatic signals and electric switch throwers, it was possible to effect the following operating economies in the haulage system of this mine:

Number of main-line motors required to move the coal from the gathering motor side tracks to tipple reduced from *three* to *two*, by reason of the increased efficiency of main-line motors resulting from elimination of unnecessary waiting time at passing points, elimination of stops to throw track switches and receive instructions from flagmen, and elimination of unnecessary waiting at gathering motor side tracks. The main-line motor relieved from regular haulage was held on the tipple yard for miscellaneous switching and relief duty.

A total labor saving on the main haulage of six man-days per day was affected by the automatic signal and electric switch thrower installation; a 33 1/3 percent increase in the efficiency of operation of main haulage motors, with a corresponding decrease in maintenance costs, and a much safer operating condition for main haulage, including mantrips, and miscellaneous equipment moved over the main haulroad at any time.

The cost of the automatic signaling and switch throwing equipment installed on the main haulway of No. 8 mine and described in this paper is as follows:

Automatic block signal (labor and material)	\$3,577.00
Electric switch throwers	1,550.00
Trip lights	203.00
	\$5,330.00

With a labor saving of six man-days per day, and an increased efficiency of main-line motors of 33 1/3 percent, the above investment in equipment installed in this mine paid for itself in labor saving alone in 127 working days. Other intangible savings effected are: More efficient haulage; compensation risks reduced; increased safety for haulage crews and equipment; economies in maintenance of hauage motors. Of the six men eliminated by this equipment, three were replaced by signal equipment and three by switching equipment.

As stated before, the installation of signals was made from a safety standpoint, but was combined with other features to effect a saving in labor. The installation has fulfilled both requirements satisfactorily, and has been in operation two and one-half years.

ECONOMIES TO BE EFFECTED BY CLEANING COAL

(*Continued from page* 83)

Often no housing or protection is put around them. Yet they will clean 80 to 150 tons a day of nut coal and do a good job of it at almost no cost.

Spirals are used successfully in a large mine to handle the pea coal, plus 1-in. minus 1⅝-in. In a plant recently burned, bituminous nut and pea were cleaned most satisfactorily, and a Montana preparation plant is experimenting with spirals now.

So coal preparation in the Rocky Mountain states, in the districts where it is well done, is not a simple proposition. The preparation plants are large, the equipment elaborate. When you consider the huge lump fed to the plant, the crushing and rescreening, the picking, handling and disposal of the rock and bony, of the degradations, the cleanup conveyors, you will visualize a large and complex plant, with a multitude of screens and conveyors.

Another Rocky Mountain plant is unique in that the plan has been worked out jointly, making use of the railroad company facilities, including its "barrel" transfer, which provides a means of dumping narrow gauge cars direct into broad gauge equipment or into the hopper (transfer) car of the coal company. The combined arrangement thus permits of successfully and economically dumping and screening domestic coal from a mine located on a narrow gauge railroad. The plant is different in that it is possible, with the portable hopper car, to dump a train load of coal and immediately remove the hopper car to a tail track, without interference with the railroad company's own operation, through the same dump. All classes of material are dumped by the "barrel," which can be loaded in open top cars.

The capacity of the plant is 300 tons of mine run coal per hour. The coal is dumped direct to a transfer hopper, thence to conveyors, which deliver it direct to the screening plant. At the end of the main belt is a receiving hopper, from which the coal is fed by a reciprocating feed direct to the screens, over which the coal is passed and prepared into various sizes, processed, and loaded into standard gauge railroad cars, by means of reciprocating feeds, booms and boxcar loaders. The plant is completely enclosed and special sky and flood lighting is a feature for interior light and improved picking.

The whole scheme was made possible and practical by the development of a portable transfer hopper car. Into this car the mine run coal is dumped, direct from narrow gauge cars of 25 tons capacity and by means of reciprocating feeds at the bottom of each hopper, of which there are four, the coal is fed sidewise to a mine run apron conveyor.

One of the newest developments in the Rocky Mountain field is the briquetting of anthracite dust screenings, formerly a by-product for which there was very little demand. A modern plant for this purpose has recently been put into operation, and is making briquettes from a mixture of about 90 percent anthracite dust with 10 percent of bituminous slack. This makes a clean, smokeless fuel having a popular demand for use in base burners and open grates.

(*Continued on page* 92)

Organization Morale and the Human Element

By John S. McKeever*

Discussion by J. D. Rogers†

WHAT is organization? The word is defined as "the connection of parts in and for a whole, so that each part is, at once, end and means." The parts are mutually dependent and must also be mutually supporting if the organization is to fully function.

In business or industry the officials and foremen are usually spoken of as the organization, but it really extends to the last workers, if it is to be a perfect unit.

Morale is a state of mind, and a high morale is a state of mind which induces a determination to succeed.

The problem, then, of the head of any industry is to weld his forces into a body, the parts of which will function toward the success of the undertaking.

The head of an industry should, of course, have a knowledge of the business, and the more detailed that knowledge the better fitted he should be for his position. But if he has perfect knowledge of the business without that rare thing known as tactful consideration of his fellow men, he will not be able to succeed.

The ability to choose men for their particular fitness for the job to be done is the mark of the successful executive. The place to get men for executive duties is on the job itself, if at all possible. There is nothing more destructive to the efficiency of an operation than for a new head to take charge and to bring at once with him men to replace some of those who have spent years there.

Every man has the thought "Will I be next?" and his work fails as the result of his mental condition. The men on the job have a better knowledge of it, its peculiar conditions, and the personnel of the workers, their strength and their weaknesses.

In nearly all instances the minor officials already on the job can be welded into a machine which will work smoothly and harmoniously toward the common goal. In this welding process the first thing to do is to give a man responsibility. Let him know that it is his job and also his burden. Let him use his own mind on many things. If you and he disagree always hear his argument and give him yours. Don't have the notion that you know it all. Out of exchange of ideas the right way will appear. Never place blame on a subordinate unless he has flatly disobeyed. If your superior advises a course of action which you think is wrong it is your duty to tell him so, and, if after hearing your objections he insists on his way, go ahead and do it as if it were your way, and if you are the superior and your way *was* wrong don't fail not only to tell *your* superior who was at fault, but also tell the man who objected that you *were* wrong.

Don't give orders to men working under another foreman, except in emergency, no matter how high your official position. Tell the foreman himself—it is his job. "Too many cooks spoil the broth," and too many bosses will spoil any workman and the bosses also.

When you give a man responsibility and he makes a mistake it is your error, and you must so regard it and so report it if necessary. That is one of the ways of supporting your men. But you must always have him know that if, in your judgment, he errs in his treatment of men under him, you will reverse him when appealed to.

Request; do not command. Most any person will do much more for the pleasant "will you" than for the harsh "you must."

Jealousies must be removed from the minds of coworkers. Good mechanics and electricians are often as temperamental as operatic stars are said to be. The good superintendent recognizes the value of the men but knows that their jealousies will disrupt his machine. He tactfully talks it over with them and if finally he can not talk them out of it he is compelled to walk them out. This, however, is rarely necessary.

Complaints from workmen must be courteously heard by every official. No matter how ridiculous it may appear to be, it is generally a real trouble to the man who brings it. He must be kindly shown when he is wrong or the condition promptly remedied if he is right.

The executive must be fair, yet firm. The boss to be envied is the one whose men will occasionally curse him among themseves, but who will promptly fight any outsider who does.

The relationship between the coal company and employes generally is different to that of nearly all other industrial organizations. This is particularly true in the newer of the coal fields. The mining camps are mostly isolated, being distant from independent towns. This is because the camp must be built near the place where the coal can be mined. Many times the area of suitable building ground is very limited and living quarters must be built on benches, on hill or mountain. Any flats are utilized to their fullest capacity. Rents must be low. At least it has been a general practice among coal companies to keep rents low. This practice results in coal property tenants paying from one-half to one-fourth as much rent as is paid for similar accommodations in independent towns.

Many companies provide church buildings and meeting halls free of expense to their employes. Some also provide funds to pay part of salary of pastor of churches. At times, also, extra funds are provided so that better teachers are secured for the public schools. Welfare workers and community nurses are retained and their cost paid by the employer.

When a coal mine works short time or is temporarily shut down, the employes must be cared for, and many comparatively small companies extend credit for house rent, food, and clothing over a period of three or four months which will and does amount to quite large sums of money. One company during a five months period this last year extended over $30,000 of this kind of credit to less than 500 employes. Very few other industries thus care for their employes in times of depression.

This sounds like as if the coal miner was a shiftless citizen. This is not true. There are as many saving, thrifty, getting ahead families among the coal miners as there are in any other industry or business. How many families do you know whose income is from one to ten thousand dollars a month who save any money? In intelligence, honesty, ingenuity, sobriety, and upright living the coal miner and his family stand high among all the citizenry of this bureau-governed land of ours.

* Superintendent, Kanawha & Hocking Coal & Coke Co.

† Stonega Coke and Coal Company.

J. D. ROGERS—*Stonega Coke & Coal Co.*

NOT having access to Mr. McKeever's paper on "Organization, Morale, and the Human Element" prior to coming to Cincinnati, I had to anticipate any discussion I might be called upon to make on this subject.

I have picked on the second item, thinking that I might in some way partially touch on his very interesting subject. Webster gives the definition of "morale" as follows:

> "Morale or mental condition as regards courage, zeal, hope, confidence, and the like; used especially for a body of men engaged in a hazardous enterprise, as soldiers or sailors in time of war."

Change the last phrase of the sentence to "miners in the production of coal" and you have the true picture.

Morale is something which must be

attained; it can not be bought with money, but it must be secured if a successful organization is to be built up to a point where it will economically function.

Probably all coal operators attending this convention think that they have built up a morale among their organization which is a most valuable asset to their respective companies; we think we have partially succeeded along these lines, and I shall attempt to mention in a brief way how we have been more or less successful in solving this problem. We are making this drive under the caption "Safety First." We are convinced that a safe man is the most efficient man to have in our employ. By this I do not mean to say that we discharge a man if he gets hurt—on the other hand, we try to get him "safety minded" so that he will not get hurt, nor will he allow his fellow workman to get hurt if he can help it. The discharging of an employe is the last step to take.

During the last five years, particularly, we have been making an effort to cut down our lost-time and compensable accidents, thereby naturally decreasing the cost per ton of our compensation charges. The results have been most gratifying, and the actual figures are as follows:

In 1927 we actually paid .0310 per ton in compensation money on every ton of coal produced for accidents happening that year. In 1928 the same charge was .0207 per ton; in 1929 the charge was .0176 per ton; 1930 the charge was .0186 per ton. In 1931 this charge was reduced to .0117 per ton. Last year one of our collieries produced 555,026 tons, and only paid out $1,105.58, or .0020 per ton, for compensation. These figures represent money actually paid out to the persons injured. This record was made in the face of declining tonnages. It has been said that low tonnages increase accident frequency per ton. I can also state that this year's record to date is better than last year's record, and we hope to keep it so.

You may now ask how this record has affected the "morale" of our organization, and benefitted same. I shall state that our men are now more careful than they used to be, the equipment which they are required to use is kept in a better state of repair, and less delays happen due to breakdowns. The men are more alert, and are continually looking for a chance to make an improvement which will better their working conditions and cut down a chance for an accident. I think that I can truly say that the old spirit of "let her go until she breaks down" has almost disappeared from our men. A spirit of cooperation and good will has taken its place, which we consider to be of inestimable value, and can not be figured in dollars and cents.

I can tell you of many 100 percent "Safety First" meetings we have held at our different collieries where approximately 90 percent of the men attending got up and made some remark pertaining to some phase of their individual work. Those meeting have been inspiring to the men in charge. I could give you countless instances which have taken place at those meetings that I am sure would be of interest to you, but time will not permit. This campaign has resulted in the building up of "morale," "efficiency," "good will," and a hearty cooperation on the part of every man employed.

No doubt there are other ways and means of securing the same results, but we are definitely sold on the safety-first method.

In closing, let me say that we were not able to accomplish this result in one or two or even three years. It has been a steady growth, and in order that you may be successful you must finally permeate this idea down to every man working at the face—the place where most of your accidents really occur.

ECONOMIES TO BE EFFECTED BY CLEANING COAL

(*Continued from page* 90)

In conclusion, suffice it to say that greater effort is being put forth than ever before, at the various preparation plants, large and small, new and old, to insure the turning out not only of the highest quality product possible, but that kind and size of product which will best serve the customers' needs.

ACCIDENT PREVENTION WITH PROTECTIVE CAPS, HARD TOED SHOES AND GOGGLES

(*Continued from page* 88)

all angles, and am satisfied that we can afford to do no less than educate this man, and education is the only way in which we can overcome the idea of man failure.

We all know some of the things that contribute to what I refer as man failure—day dreaming, wishful thinking, reveries, worry, revengeful retrospection (possibly against the mine officials), anything that keeps his hand and mind from working together.

We had an illustration of that not long ago in our own mine, a typical one. The gathering motor was pushing a load of empties at night. The brakeman went back and, as the motorman supposed and as he stated, set the brakes on the cars left, and put his block in. He uncoupled six of the cars and started out through the doorway. He went to a power switch and was going to pull that switch, but before he could pull the switch the remaining cars came down this little grade and caught him, knocked him down, and injured him quite seriously. This man had been performing that same work night after night for months, and investigation of the situation revealed that his wife was in the hospital in a state of coma, a very serious condition; the doctor had told him it would do no good for him to stay there, to go back and go to work. We had no knowledge of that, and he came back that evening and went into the place to work.

I think that speaks for itself. The man's mind was not on his work. It was a case of man failure.

In my mind, the wrong approach of a foreman and the mental reaction of the men to it cause more accidents than all other causes put together. A large number of accidents can be traced to the foreman's lack of psychological approach. The foreman must not be ignorant of the limitations and tendencies of human nature. For instance, he should not damn the person for his mistake, but should differentiate the offense from the offender. He should also compliment him for the success in the proper proportion he deserves.

When you have occasion to criticize a man, do not condemn him altogether, but just the mistake he made. Train your foremen to do that. Be sure you will get better results from them. In other words, two pats on the back to one kick in the pants is about the right proportion, I think.

All of those things combined creating hazards leave no doubt in our mind that the correction of man failure by the foreman or workman constitutes in all probabilities, if fully developed, one of the greatest single factors of accident records.

I am going to toot our own horn just a little. I had nothing to do with it personally. It was the men who did it. On the 1st of May we completed the third consecutive month with 350 men working at Harwick mine without an accident of any kind. By "any kind" I mean that we report every accident of any description that goes to the hospital for attention, and we insist upon everything going there. A lost-time accident is anything beyond the day of the injury.

I feel quite proud of our men in that record. When we passed the first month we thought it was wonderful. We passed the second month and began to hold our breath, and now we have passed the third month.

THE REAL COAL PROBLEM

(*Continued from page* 42)

developed among the consumers. Think of the reduction of the electrical industry from 3 pounds per kilowatt hour to less than 1 pound per kilowatt hour in this very period of which I am speaking. Look at the economies effected by the coal consuming railroads. Look at the economies effected in industry with the use of coal pulverizers.

I supplied coal for years to an industry which used a high grade low sulphur gas coal for its gas producers in the heating ovens in a steel rolling mill. That industry tore down those producers, put in a pulverizer, and is now using low priced slack coal to do the same work. It was induced to do that by the high price of coal. That is progress, but it is progress which is very uncomfortable for the fellow whose arrangements are disconcerted, who has to find a new market for his high priced low sulphur gas coal, but those things are going on all the time. They are going to continue to go on all the time. They mark the progress of the world, and we have got to keep step with them and we cannot afford to pass legislation which is going to hold that progress back.

I say that, in regard to any legislation, as well as this legislation. It seems to me that this legislation is particularly ill devised. So far as I can see it offers the operator the right to form a pool, which he already has, at the price of domination by the United Mine Workers of America. If that spells progress, I know nothing about the problem.

PREMIUM PAYMENTS FOR MECHANICAL LOADING

(*Continued from page* 72)

in thickness. The entire operation results in the removal of approximately 22 ft. of coal.

The payment of premium for coal loaded by Joy machines was started June 1, 1930, and, in view of the unusual mining conditions as described above, it was necessary to set a standard of tonnage expected from both the pioneer work and the removing of top coal. The rate of premium paid per ton over these standards was the same.

During the period June 1 to December 1, 1930, 5 cents per ton was paid for coal loaded over the standard set, and, after December 1, this amount was increased to 14 cents per ton which rate is still in effect.

In pioneer work, or, in other words, advancing rooms 8 ft. high on the first mining, the crew handling the loader and the room haulage to receive premium at the rates above given for all coal loaded over 250 tons per eight-hour shift, the amount of premium to be divided equally on man shift basis to those of the crew.

For top coal, the premium to be paid and divided in the same manner as that for pioneer work except that the required amount of coal to be loaded per shift of eight hours to be 300 tons and premium to be paid on tonnage over that standard.

During the period of June 1, 1930, to December 31, 1930, an average of six loaders operating 16.7 percent earned premium and loaded 22.9 percent of the Joy loader coal, the tons per man shift averaging 66.8 tons. The amount of premium earned in that time amounted to $293.55 or $.476 per shift, the average tons per man shift for all Joy loaders being 45.1 tons.

These figures were materially increased during the year of 1931, showing that, out of an average of seven loaders operating, 42.4 percent earned premium, loading 46.1 percent of the Joy loader coal produced, or an average of 65.4 tons per man shift. During 1931, $2,324.35 was paid in premiums for this coal, or $1.025 per shift, the average tons per man shift for all coal loaded by Joy machines being 50.4 tons.

At the various Union Pacific mines, there were operated an average of 15 pit car loaders of the Northern and Red Devil types. Effective January 1, 1931, the total tonnage loaded through the individual machine, in excess of 13.5 tons per man shift, earns over and above the existing wage agreement, 28 cents per ton. Loader crews on this type of machine consist of two men handling the loader. Each man employed on the pit car loader during the two weeks' period will receive his pro rata share of the total premium, based on the relative number of man shifts worked by him, extra men to participate in the premium the same as men regularly assigned to the machine.

During 1931, 33.3 percent of the pit car loaders earned premium which amounted to $230.16 or $.223 per shift. Twenty-four and eight-tenths percent of the coal loaded by pit car loaders, or 14.3 tons per man shift, was produced by machines earning premium. The average tons per man shift of all pit car loaders being 11.3 tons.

Since pit car loaders are not adaptable to all places or conditions, the operation is more or less irregular, this being the chief reason for the seemingly small figure of 11.3 tons per man shift.

Because of a lack of similarity in operating conditions in the scraper places of the different mines, it has been a rather difficult matter to arrive at a standard man shift tonnage which might be expected from these loaders, as well as at a rate of premium to be determined. After some consideration it was decided to put into effect the following rate, effective May 16, 1931: Premium of 20 cents per ton on all coal loaded in excess of 20 tons per day of eight hours for each man employed, including hoist operator, loading head man, rock cleaner, scraper operator, mining machine men, drillers, shooters and timbermen, the men enumerated to constitute a regular scraper assignment. In the event it is necessary to assign men temporarily for special timber and rock work in a given scraper place, the men so assigned are not permitted to participate in the premium division and their time is not to be counted against the scraper performance.

The scraper loader performance for the period May 16, 1931, to December 31, 1931, reveals that, out of an average of 5 scrapers operating, 21.7 percent earned premium and loaded 24.5 percent of the total scraper production. The premium earned amounted to $1,200.91, or $.727 per shift. The average machine shift tonnage of premium loaded coal amounted to 23.6 tons per shift, and for all scraper performance 16.7 tons.

Since each member of a crew is paid a premium dependent upon the average man shift tons from his machine for the half period, we have found that interest has been added by posting the premium sheets, showing the amount of premium earned, tons per man shift, etc., on the bulletin boards at the mines. This has stimulated interest and a greater desire for a good showing of the particular machine on which the workman is engaged.

To quote our mine superintendent, Mr. T. H. Butler, at Rock Springs, he says: "Our men now take kindly to the paying of the premiums and are anxious to have an opportunity to load as much coal as possible. The payment of a premium has increased the production from the shaking conveyors, and, while at the beginning of the plan the men looked upon it with more or less disfavor, they are now all very much interested in making as large a premium as possible."

Mr. M. W. Medill, mine superintendent at Reliance, adds that "before the payment of premium was started we had some very good crews and others which were just as good but obstinate. As day wage labor has always been, some of the men will do a good day's work while others will do just what is necessary in order to get by, not keeping the machines in shape, and seemingly not knowing just what to do to benefit themselves or to increase the production of coal. When we started the premium payments, we had somewhat the same trouble, some of the crews were pleased and anxious to earn the premium offered, while others did not believe in the system. We considered these crews to be efficient although they were of different opinions. By changing men here and there, one at a time, and getting everyone talking about the premium, very soon we had everyone working for it. Then we began posting a bulletin every two weeks showing the mechanical loader performance and, I believe, the bulletin was responsible for some of the good results obtained. Now every crew is in favor of the premium and we find very little difference between crews, men we thought would not make efficient mechanical loader workers have turned out to be some of the best we have."

The mine superintendent at Superior, Mr. Geo. A. Brown, says: "the payment of premiums has been an incentive for men who wanted to work to make more money per day and has had a tendency to show the management the men who would try to make the premium. We have found that some of the crews would make premium under what we term normal conditions and that others would, or could not, make it under any conditions, thus giving the management a chance to change men around to get the best results. We have found the majority of our men receptive to the premium system, it seems to have worked out very favorably and has had a tendency to increase our machine and man shift tonnage."

Mr. O. G. Sharrer, superintendent at Hanna, states that "the establishment of premium payments has assisted in breaking down the resistance to establishing record shift tonnage and this one thing has been one of our greatest benefits."

We feel that the introduction of the premium method of payment has had its benefits both for the workmen and for the company. There is no doubt that there may still be obstacles which will have to be met and adjusted but the records are proof that for each added increment of man shift tonnage there has been a corresponding decrease in tonnage cost and an increase in wages.

The Union Pacific Coal Company hopes to increase the scope of premium payments to include all mechanical loaders and to make it possible for all men employed on mechanical loading equipment to earn a premium.

THE EXPOSITION

CHARLES C. WHALEY

National Chairman,

Board of Governors,
Manufacturers Section,
Coal Division,
The American Mining Congress

Myers Whaley Company,

Vice Chairmen

RALPH C. BECKER, ***McGraw-Hill Publishing Co.***, **New York, N. Y.**

JOHN T. RYAN, ***Mine Safety Appliances Co.***, **Pittsburgh, Pa.**

GEORGE R. DELAMATER, ***The W. S. Tyler Company***, **Cleveland, Ohio.**

Convention Manager, **E. R. COOMBES**

Director of Exhibits, **L. W. SHUGG**

The 9th Annual Exposition, held under the auspices of the Manufacturers' Section, The Coal Division, of The American Mining Congress. . . .

CINCINNATI, OHIO
May 2 to 7, 1932

SEVENTY-SEVEN of the industry's leading manufacturers participated, exhibiting the latest equipment designed to increase safety and efficiency, and reduce production costs.

The following pages give a brief description of the materials exhibited. Greater detailed information may be had by addressing the American Mining Congress, Munsey Building, Washington, D. C.

AMERICAN CABLE CO. An interesting display of Tru-Lay preformed wire rope and various types of wire-rope fittings were on display. The principle of Tru-Lay preformed wire rope was thoroughly explained and demonstrated how it could be cut without seizing the ends of the rope. Because of the mechanical preforming of the individual and of the strands, uniform distribution of stresses and the reduction of internal stresses are secured. Being preformed, each strand in the finished rope tends to retain its original shape and resists unstranding.

The **AMERICAN MINING CONGRESS** exhibit consisted of a series of large panel posters, describing the various activities of the organization, in behalf of the mining industry . . . these activities include: A Coal Division, with special work on legislation, taxation, tariffs, mechanization survey, yearbook on mechanized mining, the Cincinnati convention and exposition, and standard projects looking to simplified practice. Supplemental literature was available, giving the personnel of the organization, its national committees, and specialized services.

The **AMERICAN STEEL & WIRE CO.**, in conjunction with other subsidiary companies, featured their new Monitor mining machine feed and tail rope, along with rubber-clad mining machine cable and Tiger weld rail bonds, as well as their complete line of wire and cable. Interest was aroused in their exhibit by motion pictures of freight tramway on waste disposal and aerial transportation.

AMERICAN TELEPHONE & TELEGRAPH CO. The display consisted of three Teletypewriter machines. Two machines were connected showing how it is possible to type back and forth with branch offices and plants wherever located, providing a convenient and accurate channel for handling, instantly, reports and orders of all kinds. The third machine was connected to the various press association wires and furnished up-to-the-minute news from all parts of the United States. A part of the display was a list of mining operations using Teletypewriter service.

AMERICAN WOOD PRESERVERS ASSOCIATION. This exhibit consisted of a mine set treated with zinc chloride to prevent decay; zinc chloride treated mine timbers free from decay after 25 years service in a coal mine, and literature on the preservative treatment of mine timbers.

BALDWIN LOCOMOTIVE WORKS. (See WESTINGHOUSE.)

The **BETHLEHEM STEEL CO.** exhibit featured Keystone No. 6 steel tie, used with rails weighing up to and including 60 lbs. per yard, and may be used not only for main-haulage track but for headings, entries, and rooms. Short and long clips are provided with this tie, which permits widening of the gauge on sharp curves.

Other products exhibited were the Bethlehem standard and rail extension ties, guard rail chairs, Model 1217 switch stand, mine car stop with sprag, and a rolled steel mine locomotive wheel.

The **BROWN-FAYRO CO.** exhibited a new 4 x 5 enclosed, self-oiling, piston-type mine gathering pump, embodying the patented Austin water end, which can be furnished either 4 in. or 5 in. piston diameter, mounted on a completely enclosed, ball-bearing equipped power frame. Motors of 2 to 5 hp. can be accommodated on this pump.

A new 10-hp. portable electric hoist arranged for a normal rope pull of 2,000 lbs. at an average speed of 170 ft. per minute, and provided with a rope drum having a capacity of 1,500 ft. of ⅜-in. rope. This hoist embodies the **BROWNIE** variable friction drive, a new automatic brake for particular use in connection with slow speed car-haul hoists. This brake is of the free-wheeling type, totally enclosed, ball-bearing equipped, and arranged for mounting on an extension of the motor shaft.

A completely redesigned line of **BROWNIE** rerailers and derailers for all rail sizes from 20 to 80 lbs., inclusive.

A new 24-in. throat diameter Timken bearing equipped sheave with stand. This sheave is now available in sizes of 15 to 42 in.

A new 6-in. diameter chilled cast iron Timken bearing equipped track roller, with brackets designed to guide the rope into position.

A new heavy-duty hand grease gun, arranged to accommodate connections for various types of plugs.

The standard **BROWNIE** tubing blower equipped with a new Westinghouse totally enclosed ball-bearing equipped SK motor rated 1¼ hp.

Miscellaneous samples of pump parts, strainers, control equipment for centrifugal pumps, car wheels, pulleys, sheaves, etc.

The **CARNEGIE STEEL CO.** exhibited Carnegie copper steel mine ties in a complete range of sizes and weights, light rails and fastenings, and Carnegie wrought steel wheels for mine cars and locomotives.

The **CHICAGO PNEUMATIC TOOL CO.** displayed a complete line of coal drills, consisting of mounted and unmounted of the open type and U. S. Government approved flameproof coal drills, also a line of rotary air coal drills, rock drills, riveting hammers, portable electric and air drills for maintenance work, coal-drilling accessories.

The U. S. Government approved drills are both of the very latest design in this type of drilling machine, being constructed of a new heat-treated alloy of very light weight, still strong enough to maintain the large horsepower which is contained in these drilling machines. The rotary compressed-air drilling machine is of an entirely new type, being a very light-weight machine weighing 27 lbs. and developing practically 3 hp.

CINCINNATI FROG & SWITCH CO. (See WEIR KILBY CORP.)

THE CINCINNATI MINE MACHINERY CO. This exhibit included typical samples of their varied line of coal-cutting chains, sprockets, cutter heads, and miscellaneous allied equipment.

The **CLARKSON MANUFACTURING CO.** demonstrated the features of their latest development in loading machines, which is a track-mounted self-propelled loader operated by three motors having a 90-degree swinging front loading head and a rear conveyor with a lateral swing of 40 degrees. The loading head consists of two gathering chains with picks rotating toward the center for loosening coal and dragging material to the transferring conveyor.

COAL MINING had on display copies of their publication.

CONDON BEARING & SUPPLY CO. This exhibit displayed the Guaranteed Reground Ball Bearings. These bearings, costing about 60 percent of new bearing price, were naturally of interest to operators looking for places to save money. This repair work is done by the Condon company and the bearings are guaranteed to give the same service as a new bearing.

The exhibit also contained displays of new Fafnir ball bearings and McGill ball bearings, Timken roller bearings and Hyatt type roller bearings.

An interesting folder given away at the show gives the manufacturers part number and shows the standard bearing number of the part. This data covers all the popular makes of locomotives, loaders, and other mine equipment. Additional copies may be obtained by writing to the company.

C. P. DANIEL, LTD., of the Enterprise Wheel & Car Co., manufacturers of mine cars, maintained headquarters booth only.

THE DEISTER CONCENTRATOR CO., INC., exhibited a No. 14 Deister-Overstrom diagonal-deck coal-washing table, in operation. The table was equipped with the Concenco motor drive, and the Concenco white-rubber cover and riffles which were developed by the Deister Concentrator Co.

The double-deck Leahy heavy-duty vibrating screen, shown in a 4 ft. x 9 ft. type, was equipped with surfaces of both perforated plate and wire. The screen was driven by a 1-hp. motor, and was demonstrated. A Concenco tilting mechanism gave adjustable slope to the screen. The screen vibrates the screen surfaces only and does not transmit vibration to the screen frame, supporting structure, or building.

A Leahy vibrator was shown, which demonstrated the mechanical make-up and working of the vibrator. This vibrator was equipped so that the characteristic Leahy differential vibration was recorded as a curve. This differential vibration gives an unblinding action 1,600 times a minute. Many photographs of new anthracite and bituminous installations were shown on a continuous display machine.

The **DUNCAN FOUNDRY & MACHINE WORKS** had their Duncan roller-bearing wheel, self-oiling wheel, and Timken bearing wheel on display. The most interesting thing being the two wheels equipped with Timken bearings mounted on stub axles to demonstrate the difference resulting in methods employed in boring out of wheels.

E. I. du PONT de NEMOURS & CO.'S participation in the exposition consisted of the exhibit of an illuminated bulletin board, upon which was shown a brief description of the permissible explosives extensively used by the coal-mining industry. There was also a description of the three types of Pellet Powder which have been developed, and distributed by the explosives department of the du Pont Company. A description was also given of the new electric blasting squib, which is used in connection with blasting powder.

EDISON STORAGE BATTERY CO. exhibited parts and make-up of the Edison battery; cutaway cells showing the assembled parts in place; dummy cells; a tray of cells; mine safety lamps, and other appliances.

ELECTRIC RAILWAY IMPROVEMENT CO. exhibited a complete line of rail bonds designed for application by either the copper arc weld process or the steel arc weld process. In addition they exhibited for the first time a new type rheostat known as their type SBR-2. This is very ruggedly constructed and employs more rigid, greater strength resistance elements than are usual. It is claimed their construction results in a machine of longer than usual life.

The **ELECTRIC STORAGE BATTERY CO.'S** booth consisted of an exhibition of the various types of Exide ironclad batteries and Exide flat-plate batteries used in mine-locomotive service. Of particular interest to mining men, probably, was the Exide ironclad battery, known as the Type TL. Each cell of this type battery, while occupying no greater base area than the familiar MVA Type, containing the same number of plates, has a capacity 43 percent greater.

The **FAIRMONT MINING MACHINERY CO.** exhibit occupied two booths. The chief attraction was a working model of a Peale-Davis pneumo-gravity dry-cleaning table. This model was a replica of one of the larger capacity Peale-Davis units. It was supplemented by an exhibit of photographs and blue prints describing various Fairmont installations, such as cleaning plants, complete coal tipples, conveying equipment, and various specialties, such as car retarders, pumps, vibrator screens, bit-tempering machines, etc.

The **GENERAL ELECTRIC CO.** Standard equipment consisted of a single operator arc welder in operation, samples of various electrodes, G-E handy floodlights, a photo tube relay in operation, and a G-E thrustor in operation. The thrustor and photo tube were so set up that the moving element of the thrustor intercepted a beam of light falling on the photo tube. This would open the circuit to the thrustor and permit the moving element to return to its normal position, thereby reestablishing the beam of light to the photo tube. In this way the operation of the thrustor was automatic and periodic, having a period of about one to two seconds. Samples of cable were also on display.

An interesting display of laboratory demonstrations was shown. Three high-frequency demonstrations revealed induction lighting and heating. A thyratron tube demonstration showed how smoothly and gradually voltage on lamps can be increased or decreased with the aid of the versatile thyratron tube. In another exhibit eight thyratrons in inverter circuits were used to produce notes in a loud speaker.

GENERAL STEEL CASTINGS CO. This exhibit consisted of a one-piece cast-steel underframe which was one of a lot being furnished for one of the large anthracite operators. This underframe, which weighs 1,800 lbs., replaces 185 parts, bolts, and rivets, and saves 600 lbs. weight per car over the construction displaced.

The **GOODMAN MANUFACTURING CO.** featured a new automatic transfer switch, a new universal type headlight, and a new ball-bearing cutterhead which is interchangeable with standard cutter-heads. Armature coils, true circle bushings, augers and bits, chain blocks and Simplex jacks were also included in their display, along with pictures and literature on Goodman, Mancha, and Conveyor Sales equipment.

HAZARD WIRE ROPE CO. A very interesting display of Lay-Set preformed wire rope and various types of wire-rope fittings was on display in the Hazard Wire Rope Co. booth.

The **HENDRICK MANUFACTURING CO.** exhibit consisted of perforated metal screens, with round, square, and slotted holes; also special flanged-lip screens and vibrating screen plates for the screening and sizing of the different grades of coal. A piece of milled slot screen was shown and considerable interest was manifested in the same. This type of screen is used in dewatering of small sizes of both anthracite and bituminous coal, and also used as a desanding screen in all types of coal-washing plants. In addition, test screens and elevator buckets were on exhibit.

HERCULES POWDER CO. Differing slightly from previous years, display consisted of a large panel with striking message entitled "Safety, An Important Factor in the Consideration of Explosives." The exhibit called particular attention to the safety and efficiency of Hercules explosives and emphasized the care and research which Hercules explosives engineers have applied to the manufacture and development of permissible and other safe explosives. Another of the primary considerations in the manufacture of Hercules explosives is ultimate blasting costs.

HULBURT OIL & GREASE CO. This exhibit consisted of a full line of Hulburt quality grease specifically adapted to coal-mining conditions. Also descriptive matter showing savings produced by modern application of quality lubricants.

The **HYDROTATOR CO.** exhibited a working model of their air-sand separator, which was so designed and constructed that it cleans coal of about ½ in. in size. Demonstrations were made showing how impurities are separated from the coal. Another part of the exhibit was a tubular receptacle containing sand. Air from a blower was introduced into the receptacle through a porous plate and the sand particles would then be put in motion, demonstrating the fact that coal would float and refuse sink in the bed of aerated sand.

THE JEFFREY MANUFACTURING CO. occupied two booths. No actual equipment was shown. The booths had a background composed of enlarged photographs of the following equipment: 57 B sectional conveyor; 52 B sectional belt type; 52 D sectional belt type room conveyor; 40-ton tandem haulage locomotive; step multibladed fan; and 29 L arcwall coal cutter; while in the booth a large photograph of an Aerovane mine fan was mounted on a stand, and from a table a continuous movie projector showed various types of Jeffry equipment.

JOY BROS., INC., exhibit attracted unusual attention. Highly standardized equipment for the "powderless mining" of coal was shown in operation, including a coal-sawing machine and hydraulic pressure device to be used as a substitute for powder in dislodging coal. The coal saw embodies features that permit the rapid sawing of vertical or horizontal slots at any point between the roof and floor of the coal seam. Dirt seams may be sawed out separately and eliminated from the coal at the face. The blocks of coal that result from the horizontal and vertical sawing are dislodged, ready for loading, by means of the hydraulic device known as the breaker pad.

JOY MANUFACTURING CO. announced the new low-type 8 BU Joy loader and the broader Joy service given by the recently completed manufacturing and sales agreement with Mavor & Coulson, Ltd., of Glasgow, Scotland. The exhibit of cutting machines, loading machines, and conveying units occupied the entire width of the lower end of North Hall. The Joy-M. & C. Samson coal cutter was shown as a completely assembled unit; also skeleton assemblies of all moving parts in both the low-seam Samson and the standard shortwall Samson cutting machines. The new type 8 BU Joy loader, with an overall height of 35 in., a total gathering width of 64 in., and length of 20 ft. 5 in., was shown for the first time. This unit is designed and constructed along the lines of the type 7 BU Joy loader, with the patented gathering device and flexible single-strand conveyor, but is considerably lighter in weight and required horsepower. The 8 BU is guaranteed at a loading rate of 1½ tons per minute. Both Joy-M. & C. troughed belt and flat face belt conveyors were exhibited. All Mavor & Coulson products will be manufactured and sold exclusively by the Joy Manufacturing Company in the United States.

The **KOPPERS - RHEOLAVEUR CO.** display consisted of a continuously operating motion picture film showing outside and inside views of several Rheolaveur installations. The plants selected for illustration in this way were an anthracite plant, a bituminous plant cleaning Pocahontas coal, and a bituminous

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plant cleaning Pittsburgh seam coal. Various phases of cleaning were exemplified by motion pictures taken during normal operation. The exhibit also included a display of over a hundred photographs of Rheolaveur plants, both American and foreign; the Carpenter centrifugal dryer, and Rheolaveur laboratory methods and facilities for the preliminary investigation of coals.

A. LESCHEN & SONS ROPE CO. displayed samples of various kinds and types of wire rope for mining purposes. Both round strand and patented flattened strand types were shown. Moving pictures of manufacturing processes and views of the Leschen plant were screened for the operators.

The **LINK-BELT CO.** featured the "Simon-Carves Coal Washer," having descriptive literature and photographs of installations, along with catalogs and data books. The usual handy Link-Belt envelopes were handed to visitors, and a unique and novel attraction in the form of a "Photographer's Studio" enabled visitors to have their picture taken and developed in one minute. Various samples of chains, belt conveyors, idlers, etc., completed the exhibit.

THE LORAIN STEEL CO.'S exhibit was made up of the following articles: Sectional conveyor with loading boom, single and double chain types; Langham collapsible mine post jacks; all-steel mine car; timber jacks; parallel ground throw switch stand.

McGRAW-HILL PUBLISHING CO. COAL AGE magazines and COAL-MINE CATALOGS AND DIRECTORIES.

The **McNALLY - PITTSBURG MFG. CORP.**, in addition to displays of information and literature on general tipple and preparation plant installations, showed a motion picture featuring the automatic controls of the Norton automatic coal washer. The pictures, taken at the plant of the Montevallo Coal Co., graphically depicted the operations of the automatic control of the refuse discharge gates and the automatic control of the washing operation.

MACWHYTE CO. exhibit consisted of a reel containing samples of mine rope. They showed samples of wire rope used on shaft hoist, shovels and draglines, mining machines and loaders, etc. Also samples of Monarch mine car hitchings used for mine-car coupling.

A new booklet on wire rope for mining, including the latest literature on wire rope made especially for mining purposes, was given delegates. Additional copies of this booklet are available.

A special feature of their wire rope is the internal lubrication, and samples of lubricants were on hand for inspection, as were also samples of Macwhyte preformed wire rope.

MANCHA STORAGE BATTERY LOCOMOTIVE CO. (See GOODMAN MFG. CO.)

THE MINING CONGRESS JOURNAL booth consisted of a huge panel background setting forth the editorial policy of the Journal, the purpose of its various departments, and special facts concerning the clientele it seeks to serve.

MINE SAFETY APPLIANCES CO. featured a complete line of Edison electric safety lamps, including the new Models J and K, which have been officially approved by the U. S. Bureau of Mines and the Mines Department Testing Station of Great Britain. The Edison Model J lamp was developed to meet demands for a light-weight, compact, and efficient storage-battery cap lamp, primarily for use in thin seams and low working places. It has the lightest weight mine lamp battery of its kind available today.

The Edison Model K lamp develops a maximum of 55 candlepower. Additional lamp features included the new Edison hand lamp, Models H and K, and a new single-cell Edison trip lamp. Permissible portable floodlights were also shown.

In addition to the Edison display, they exhibited a new combustible methane gas indicator, the new mine-car safety blocks, new miner's goggle, skullgards and protective hats, respiratory protective equipment, including the Burrell all-service gas mask, the M-S-A self-rescuer and the McCaa two-hour oxygen breathing apparatus; also a complete line of first-aid materials and safety clothing.

THE MINING SAFETY DEVICE CO. exhibit consisted of operating models of various improved car-control units. Particularly featured was an air cushioned bumper stop car feeder or cager suitable for use with any type of dump or for shaft bottom installations. The air-cushion principle of this car feeder removed all possibility of damage to the car wheels or axles and brings the trip to a stop without jar and consequent spillage. Other models included Horn type car cagers and feeders, mine-car retarders, and rotary and cradle dumps.

MYERS-WHALEY CO., INC., exhibited their No. 3 size Whaley automat in operation, a working model of the Myers-Whaley shovel, and photographs of both machines showing them operating under widely different conditions.

NATIONAL CARBON CO., INC., exhibited carbon graphite and metal graphite brushes, welding carbon products, and Gredag lubricants at their booth. Other units of Union Carbide & Carbon Corporation exhibited: U. C. C. methane detector, 100-lb. drums Union carbide (miner's lamp size), carbide drum pyramids (miner's lamp size), 100-lb. drums carbic cakes, No. 14 carbic lamp, No. 2 carbic lamp, Linde "K" cylinders, P. O. L. "KW" cylinders, P. O. L. "WC" cylinders, P. O. L. "B" tanks (polished), P. O. L. 5-in. 1 outfit (mounted), oxweld two-wheeled truck, oxweld welding and cutting torches, regulators, gauges, etc., Everready single-shot firing units, Everready permissible flashlights.

The **NATIONAL MALLEABLE & STEEL CASTINGS CO.** had their hitchings, couplers, and wheels for mine cars at their booth, as well as their cast-steel steam-shovel chain.

NATIONAL SAFETY COUNCIL had a special mine safety exhibit, including literature on and outlines of safety campaigns, and the services of their organization.

NIAGARA CONCRETE MIXER CO. exhibited one of their 4 x 8 double-deck machines. This machine was specially constructed, high-speed machine for dewatering and screening the very fine coal.

The **OHIO BRASS CO.** exhibit included a complete line of overhead trolley and feeder wire equipment, welding machines, mine headlights, circuit-breaker switches, mine safety switches, motor starters, approved gas-proof junction boxes, approved coal drill, porcelain insulators, and valves.

The **POST GLOVER ELECTRIC CO.** exhibit consisted of P-G steel grids for haulage and gathering locomotives, mining machines, coal loaders; P-G mine duty self-starters for fan, pumps, and other services; P-G automatic transfer switches for both single and double trolley and reel service; exclusive distributor; Tulc mining lubricants; complete line of ball, roller bearing, and cup greases. Also prepared packing and replenishing lubricants for all waste-packed boxes. Distributor; universal cast-iron pipe, both plain and cement lined.

The **PURE OIL CO.** exhibited and demonstrated their complete line of oils and greases prepared especially for industrial lubrication. A mine-car wheel revolving in a container of water was used to demonstrate enduring properties in their grease.

ROBERTS & SCHAEFER CO. exhibited a model of the new Ro-Sieve screen. Special features of the design, in addition to large capacity, low horsepower screening efficiency, are accessibility of all moving parts, simpler system of lubrication, and lower maintenance cost. They also presented for the first time the Wuensch differential density coal-cleaning process, introduced in response to a growing demand for extreme refinements in coal cleaning. It is capable of removing the ordinary refuse materials, including slate and heavy bone, from coal at low cost, and yet is so sensitive it can be applied to the most difficult problem of low gravity or three-product separation. This machine is suitable for washing all sizes of coal, including slack.

Moving pictures of the new Kleen Blox processing plant of the Glenn Smith Fuel Co., of Council Bluffs, Iowa, together with samples of Kleen Blox coal made from this process, were shown. Models of car spraggers, and photographs of completed tipples and coal-cleaning plants were also exhibited.

ROBINSON VENTILATING CO. The small ventilating unit with gasoline motor drive which was exhibited is intended for auxiliary ventilation where the unit is placed outside blowing down into a shaft while sinking the shaft. This unit is very light and is equipped with steel loops at the sides of the blower so that it can be carried easily by inserting a pipe handle through the loops.

Another new type of fan on display was the portable man cooling fan of the small size, 16-in. diameter wheel, with a cast aluminum four-blade propeller type wheel mounted on the end of the motor shaft. These small units are made in sizes 12 in. up to 24 in. with an adjustable top so that the air can be blown up or down from the point where the fan is placed. Various motors can be furnished with high speed or low speed, depending upon the volume of air desired from the particular size unit. These units are used in power houses and also to supply fresh air to hoisting engineers. On account of the rugged construction of this unit and the high-grade motor used, the life of the unit is practically unlimited.

JOHN A. ROEBLING'S SONS CO.'S booth attractively displayed samples of wire rope, a collection of trolley wire samples, and a group of woven-wire fabrics samples. The main attraction was a 36-in (full size) cross-section sample of the cables which support the George Washington Bridge.

The **SAFETY MINING CO.** exhibited their new model Cardox cartridge, which was one of four types shown. The new model is 1¾ in. in diameter, 24 in. long, and weighs 9 lbs. Two of the four models have been given certificates as permissible blasting devices from the Bureau of Mines.

SANFORD - DAY IRON WORKS, INC. This exhibit consisted of model mine cars and wheels, together with moving pictures.

STANDARD OIL CO. (IND.). This exhibit consisted of a lighted, revolving, gilded structure displaying samples of the various types of oils and greases necessary to thoroughly, satisfactorily, and economically lubricate mine machinery and equipment.

In addition, engineering bulletins pertaining to the lubrication of various types of industrial equipment were distributed, featuring Engineering Bulletin MI-129, "Mining Equipment and Its Lubrication." Also copies of "Inside Information," dealing with the construction, operation, and lubrication of automobiles; "From the Ground Up," dealing with the construction, operation, and lubrication of airplanes; "Mine Car Lubrication" and "Story of Petroleum" were given away.

STREETER-AMET CO. showed their equipment, ingeniously displayed in the form of a section of mine track and a quarter-size moving mine car similated the actual conditions of a mine weighing station. A light indicates to the trip rider or locomotive operator that the scale is properly serviced and the track clear for another weight. Control is affected by a patented hydraulic system which gives the rapid and smooth indicator movement necessary to quick and accurate weighing. This same control makes it possible to operate under the extremely adverse conditions of vibration encountered in tipple installations. The arrangement of equipment makes it possible to obtain automatic printed weights without the presence of an attendant. The accuracy of the equipment was strikingly demonstrated by the response evinced by adding or removing 1-lb. weights from the full load.

The features which received the greatest attention were: 1. Elimination of controversial weights and the ability to refer back to printed weights. 2. Extreme accuracy and wide range of capacities. 3. Weights while in motion, thereby speeding up the tipple operations. 4. Impartial automatic weights creating better feeling between operator and miners.

SULLIVAN MACHINERY CO. showed operating model of British longwall mining practice, showing the application of Sullivan double-drum scraper hoists. This model illustrated the necessity of close timbering at the face in low coal; the use of the gate-end loader for carrying the coal into the mine car as it is dumped through the bridge across the "dent" or brushed road; and also the hinged-back type of box scraper.

A set of 21 photographs showing the history of the development of the coal-cutting machine from 1892 down to date. The first of this series being the compressed-air rotary-bar machine with a separate device for removing the cuttings from the machine which was exhibited at the World's Fair in 1893. Succeeding pictures showed the various developments in mining machines down to the present-day design.

The new nickel molybdenum cutting chain with "Supersteel" alloy bits was exhibited, showing a direct comparison of size, shape, weight, and material with the old-style carbon-steel chains.

The feature of the **TIMKEN ROLLER BEARING CO.** display was a mine-car axle of a type which has been successfully used in nearly 200,000 mine cars. This axle had one journal cut away to demonstrate the mounting of the bearing and the refinement in design which is responsible for its use as standard by almost 1,000 of the country's coal-mine operators. This display created a great deal of interest because of the universal use of this bearing in mine-car service, as over 90 percent of the new mine cars put in service during the last few years have been so equipped.

The Timken exhibit also included a cut-away Timken railroad journal box mounting, driven by a small electric motor, demonstrating the operation of the bearing in steam railroad service. These bearings are now being used by 139 steam railroads in rolling stock.

The **TOOL STEEL GEAR & PINION CO.** exhibited an assortment of gears, sprockets, and similar hardened steel parts for repairs in mining locomotives and machines. They also displayed a wisdom-tooth pinion that had given unusual performance and greatly improved operating characteristics of a locomotive.

THE W. S. TYLER CO. interested coal-mining men with their type 70 "Spring Hum-mer" screen, which was designed to handle coarse and medium grades of material. Literature was available on their other woven-wire screens and screening equipment.

TYSON ROLLER BEARING CO. displayed the many sizes of their cageless tapered roller bearings, which range from ¾-in. bore to 16-in. outside diameter. A cutaway section of a mine-car wheel with bearings mounted in was shown.

UNIVERSAL LUBRICATING CO. displayed a complete line of Tulc mining lubricants and ball, roller bearing, and cup greases; also prepared packing and replenishing lubricants for all waste-packed boxes. This display was held in conjunction with Fost-Glover Electric Company, who are exclusive distributors of Tulc products.

Part of the **U. S. BUREAU OF MINES** exhibit showed, by means of placards and pictures, where artificial respiration should be used and by the operation of a man-sized mechanical manikin setup how it should be administered. This part of the exhibit has been shown to a total of more than 3,000,000 people.

Another part of the exhibit featured the Holmes Safety Association and the Joseph A. Holmes Safety Association, their organization, their objectives and accomplishments, and reasons for each.

The **WEIR KILBY CORPORATION,** which recently acquired the Cincinnati Frog & Switch Co., used two booths to exhibit the Weir Titan frog and the Champion Parallel throw switch of the Cincinnati Frog & Switch Co. The Weir Titan guard-rail clamp, Cincinnati clamps for applying extension switch points, and various types of parallel and right-angle switch stands with spring and rigid connecting rods were also shown.

WESTERN CARTRIDGE CO. featured Protecto-Spool electric blasting caps and looped or folded wire electric caps—all in insulated packages to insure safety.

WESTINGHOUSE ELECTRIC & MFG. CO. exhibited new developments including a new mining "Cold-Arc" controller operating under extreme voltage and load conditions; the "AB" De-ion circuit breaker for replacing fuses, safety switches, etc., on low-voltage circuits; a gear-motor with speeds ranging as needed from 69 to 1,550 r. p. m. up to 15 hp. ratings for driving hoists, conveyors, etc., and a general purpose explosion-tested A. C. linestarter.

A working demonstration attracting wide attention was a magnetic controller actually operating a motor under wide variations in loads and voltage. The type A.B. De-ion circuit breaker was another radically new development on display. This breaker is exceedingly small and compact considering its arc-rupturing capacity of 10,000 amperes.

The gear-motor exhibited showed a speed reducer built onto the end bracket of a standard-type squirrel-cage induction motor. A large range of operating speeds from 69 r. p. m. to 1,550 r. p. m. in ratings up to 15 hp. are available.

A new contribution to the mining industry, a Coal Mining Handbook, was distributed. It gives a pictorial story of the electrification of coal mines from the face to the market, and engineering treatises on several of the major problems of electrification.

The **WEST VIRGINIA RAIL CO.** exhibit included a full line of all the special sections that are rolled by this plant for track work pertaining to mines and industries, together with a display of their various types of mine ties, beginning with small ties for light room work and running through the line up to and including heavy main-line tie.

They also had on exhibit a rail section, which attracted considerable attention, made to the proper dimension of an ASCE section rail of the weight of 5,000 lbs. per yard. Of course, no commercially manufactured rail is such size, but this model section was true to scale for a weight of rail of this weight.

WILLSON PRODUCTS, INC. A considerable interest in safety work as applied to the coal-mining industry was evidenced at the booth of Willson Products, Inc., manufacturers of a complete line of eye protective and respiratory devices.

Several newly developed protective devices were shown, along with the regular Willson models, including a goggle with hard, clear lenses which fits over a worker's regular spectacles, affording protection from flying fragments, chips, etc.

Many observed the very interesting demonstrations made by the Willson representatives showing the rigid tests which the hardened lenses must pass for clarity and strength to withstand impact from severe blows.

Those who visited the Willson booth expressed satisfaction for having gained one impression at least—that protective equipment saves not only eyes and health for the worker but money and lost time for the company.

MAX WOCHER & SON CO. The booth of Max Wocher & Son Co. displayed the latest first-aid equipment, including first-aid kits, stretchers, and furniture. A nurse was in attendance at all times at the Wocher space to serve anyone injured at the show. Health appliances and equipment were also exhibited.

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